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Visits to 35 industries and professional offices throughout California and interviews of 219 draftsmen and supervisors were conducted to determine: (1) the effects of automation on the needs of industry for draftsmen with general versus specialized training, and (2) the curricular revisions in vocational drafting programs in junior colleges to meet the needs of automation. A survey questionnaire was sent to 87 public junior colleges to identify: (1) the general nature of the programs, (2) which colleges were using computer assisted design and drafting for numerical control, and (3) which colleges had an established program in architecture, engineering and production. Visits were made to 20 of the most innovative colleges and 44 instructors were interviewed. The conclusions were: (1) There is very little need for skills or knowledge regarding computer aided drafting at present, (2) Automation is not greatly influencing the needs for draftsmen, (3) Numerical control machining operations had little effect on the draftsman's work, (4) More emphasis should be made on curriculum content, and (5) Teachers of drafting should relate job descriptions to their students. A list of the participating companies and 2-year colleges is included. (GR)

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FINAL REPORT

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William T. Husung Jr.

Citrus College

Azusa, California

June 30, 1969

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PREFACE

The concept of automated drafting presents many possibilities for valuable research projects and reports. No attempt was made in this study to describe the various types of automated drafting devices in use today or planned for use in the near future. Recent publications on computer graphics will provide the reader with detailed information on the machines and their capabilities.

This is a study of the draftsmen who are or will be working closely with the machines, a study of their current job needs and functions, and their recommendations for upgrading drafting training. The draftsmen, supervisors, and managers who participated in this study gave their time and knowledge of the present needs of draftsmen and their opinions of the future needs to help those who will be working to establish and maintain the communications links from research and design to documentation and production. These men and women were most eager to cooperate with a study that might help to promote better recognition of the professional technician status of the service occupations which tend to be overlooked in the glamour and excitement of scientific discoveries and advancing technologies.

This is also a study of the present training programs in the junior colleges of California. Whether they are called, "junior colleges," "community colleges," "city colleges," or any of the other popular names, the public two-year colleges in California represent a facet of education unparalleled in any other state or in any other country of the world. It is hoped that the practices and programs reported by the California junior colleges will be of value to the study or development of college drafting programs elsewhere.

ACKNOWLEGEMENTS

Suggestions for the design of this study came from many directions: fellow educators, county and state supervisors and coordinators of vocational and technical educations, professors of graduate courses in vocational education, managers and supervisors of drafting departments in industry, engineers and architects, and the vast profusion of published writings on the changing needs of draftsmen.

Special mention should be made of the assistance rendered by the California Council of the American Institute for Design and Drafting, the Peninsula Drafting Management Association, and members of the American Institute of Architects for their assistance in suggesting contacts for interviews in industrial firms and professional offices throughout California.

The following companies and professional offices participated in the study enabling the director to discuss the project with management personnel and permitting the use of their facilities and time for interviews with their draftsmen and supervisors. Without the interest in educational research and the generous cooperation on the behalf of these firms, this study would not have been possible.

Aerojet-General Corp.	Azusa
American Bridge Div., U.S. Steel Corp.	San Francisco
Ampex Corporation	Redwood City
Austin, Field & Fry, Architects	Los Angeles
Autonetics, North American Rockwell, Corp.	Anaheim
Beckman Instruments, Inc.	Fullerton
C F Braun Inc.	Alhambra
Collins Radio Co.	Newport Beach
Conrac Corporation	Covina
Daniel, Mann, Johnson & Mendenhall	Los Angeles
Fairchild Semiconductor Div.	Mountain View
General Dynamics/Convair	San Diego
General Dynamics Corp.	Pomona
Hoffman Electronics Corp.	El Monte
Honeywell Corp.	San Diego
IBM Corp. Systems & Manufacturing Div.	San Jose
Jet Propulsion Laboratory	Pasadena
John A. Blume & Associates	San Francisco
Kistner, Wright & Wright	Los Angeles
Koebig & Koebig	Los Angeles
Lockheed Missile & Space Co.	Sunnyvale
Los Angeles City Department of Water & Power	Los Angeles
Los Angeles County Engineers Office	Los Angeles
Los Angeles County Division of Architecutre	Los Angeles
Los Angeles County Road Department	Los Angeles

Neptune & Thomas & Associates	Pasadena
Philco Ford Corp.	Palo Alto
RCA West Coast Division	Van Nuys
Rocketdyne, North American Rockwell Corp.	Canoga Park
Rohr Corporation	Chula Vista
Southern California Edison Co.	Los Angeles
Standard Oil of California	San Francisco
TRW Power Space Division	Redondo Beach
U.S. Naval Shipyards	San Francisco
William Pereira & Associates	Los Angeles

At the outset of this study, survey questionnaires were sent to 87 California public two-year colleges. The following 81 responded to the survey. Those marked with an asterisk were later visited for personal interviews with drafting instructors. The assistance and cooperation of all the colleges listed and the participation of the instructors who were interviewed were both encouraging and gratifying.

*American River College	Sacramento
Antelope Valley College	Lancaster
Bakersfield College	Bakersfield
Butte College	Durham
Cabrillo College	Aptos
Canada College	San Mateo
Cerritos College	Norwalk
Chabot College	Hayward
*Chaffey College	Alta Loma
*Citrus College	Azusa
Coalinga College	Coalinga
Columbia Junior College	Sonora
*Compton College	Compton
Contra Costa College	San Pablo
Cuesta College	San Louis Obispo
Cypress Junior College	Cypress
De Anza College	Cupertino
Desert, College of the	Palm Desert
Diablo Valley College	Pleasant Hill
*East Los Angeles College	Los Angeles
*El Camino College	El Camino
Feather River College	Quincy
*Foothill College	Los Altos Hills
Fresno City College	Fresno
Fullerton Junior College	Fullerton
Gavilan College	Gilroy
*Glendale College	Glendale
*Golden West College	Huntington Beach
*Grossmont College	El Cajon
Hartnell College	Salinas
Imperial Valley College	Imperial
Laney College	Oakland
Lassen College	Susanville

*Long Beach City College	Long Beach
Los Angeles City College	Los Angeles
Los Angeles Harbor College	Los Angeles
*Los Angeles Trade-Technical College	Los Angeles
Los Angeles Valley College	Van Nuys
Marin, College of	Kentfield
Merced College	Merced
Merritt College	Oakland
Miracosta College	Oceanside
Modesto Junior College	Modesto
Monterey Peninsula College	Monterey
*Moorpark College	Moorpark
Mt. San Antonio College	Walnut
Mt. San Jacinto College	Gilman Hot Springs
Napa College	Napa
Ohlone College	Fremont
*Orange Coast College	Costa Mesa
Palomar College	San Marcos
Palo Verde College	Blythe
*Pasadena City College	Pasadena
Redwoods, College of the	Eureka
Rio Hondo Junior College	Whittier
Riverside City College	Riverside
*Sacramento City College	Sacramento
Saddleback College	Mission Viejo
San Bernardino Valley College	San Bernardino
San Diego City College	San Diego
San Diego Mesa College	San Diego
*San Francisco, City College of	San Francisco
San Jose City College	San Jose
*San Mateo, College of	San Mateo
Santa Ana Junior College	Santa Ana
Santa Barbara City College	Santa Barbara
Santa Clarita Valley Junior College District	Newhall
Santa Monica City College	Santa Monica
Santa Rosa Junior College	Santa Rosa
Sequoias, College of	Visalia
Shasta College	Redding
Sierra College	Rocklin
Siskiyous, College of the	Weed
Solano College	Vallejo
*Southwestern College	Chula Vista
Taft College	Taft
*Ventura College	Ventura
Victor Valley College	Victorville
West Los Angeles College	Los Angeles
West Valley College	Campbell
Yuba College	Marysville

The writer is indebted to many of the professors and members of the staff in the School of Education at the University of California at Los Angeles. To name them all would not be feasible but recognition must certainly be made of the assistance provided by the members of the writer's doctoral committee and others who provided early encouragement and suggestions for the development of the design. The suggestions by Professors Carl Weinberg and Bruce Reinhart for the research techniques and data treatment provided the practical development of nebulous ideas. The interest in and critique of the original design by Professors Allen B. Rosenstein and Edward B. Johns helped to focus the writer's attention on the perceptions of those not closely alligned with this field of vocational education. But most of all, the writer is most deeply indebted to Professor Lynne C. Monroe, a good friend and inspiring advisor for many years and to Professor Melvin L. Barlow, the Chairman of the Committee, a model of excellence in contributions to the professional status of vocational education and an ever-edifying counselor.

Certainly the writer would be remiss if he failed to express his appreciation to the administrators of Citrus College and the directors of the Citrus College Foundation for their willingness to sponsor a project of this type even though it meant entering into new types of negotation arrangements and required extra efforts from many members of their staffs.

Finally, the writer must express his most hearfelt gratitude to his wife, Barbara and five children who so patiently waited for his time, when the study came first. Perhaps now some of those lost times together can be reclaimed.

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SUMMARY

Purposes

The purposes of this study were to determine:

1. The effects of automation on the needs of industry for draftsmen with general versus specialized training.
2. The curricular revisions in vocational drafting programs in California junior colleges to meet the needs of automation.

Procedures and Populations

A total of thirty-five industries and professional offices throughout California were visited and 219 draftsmen and 58 supervisors were interviewed. The draftsmen were selected from the fields of architecture, and civil, electronics, mechanical and structural engineering. Included in the interview procedure was the use of a rating scale check list of 173 job skills and functions representative of draftsmen's duties.

A survey questionnaire was sent to the eighty-seven public junior colleges in California:

1. To determine the general nature of their drafting programs.
2. To identify those colleges that had demonstrated progress in planning for and providing instruction in computer assisted design and drafting for numerical control.
3. To identify those colleges that had established option programs in drafting for the specialized disciplines of architecture, engineering and production.

Personal visits were made to twenty of the most innovative colleges and forty-four instructors were interviewed. The same drafting skills check list was used to compare the emphasis of their programs with the needs expressed by draftsmen in industry.

Results

The draftsmen in industry indicated that they had very little need for skills or knowledge regarding computer-aided drafting at present, and if any training was needed in the future, it would probably best be done on the job to suit the types of equipment installed by the company. There was not any great amount of agreement as to how limited or specialized a draftsman should be. However, most draftsmen seemed to favor flexibility at least to the point of being capable of working in two related fields as electronics and mechanical drafting or architectural and structural drafting so that they might be easier to place when work loads required re-assignments of personnel.

Automation is not greatly influencing the needs for draftsmen. Draftsmen are still very much in demand, and well trained draftsmen will be needed for many years to come. In some fields the automated devices are taking over some of the tedious detail drafting previously done by engineers. Some of the lettering operations on drawings and material lists previously done by draftsmen are being performed on typewriters and other type-printing devices. Although this procedure may not be considered automated in an electronic sense, it may be thought of as an improvement in the overall system of production of drawings as a result of new equipment in drafting technology.

Numerical control machining operations were found to have little effect on the draftsman's work particularly for those that have been working with a form of base-line or coordinate dimensioning applicable to numerical control. Conventional working drawings made using these systems of dimensioning are satisfactory for current part programming operations.

The draftsmen and supervisors suggested curriculum revisions for the vocational drafting programs that would include more emphasis on:

1. Related technologies with shop work or laboratory demonstrations of industrial practices.
2. Instruction in basic drafting techniques according to industrial standards and professional practices.
3. Professional and office practices in documentation.
4. Work experiences or field trips to observe drafting practices.
5. Mathematics--generally through trigonometry.

The recommendations in general were for teachers who were more familiar with current practices in drafting to bring the job situations into the classroom or to help the students observe the work of the draftsmen as they would find it on the job.

Of the eighty-seven public junior colleges in California, eighty-one responded to the survey, and sixty-seven reported some type of drafting program. The drafting programs offered by the junior colleges in the order of frequency named were; general drafting 53, architectural drafting 45, mechanical drafting 44, electronics drafting 31, civil drafting 20, and structural drafting 15. Nine other specialized drafting options were reported, but none of them by more than one college.

Only one college reported having a computer aided cathode ray tube for the use of drafting students. Two colleges reported having digitizers, and two others reported having plotters for the use of students on campus. Several colleges added that they were hoping to obtain some type of automated drafting equipment in the near future. Only eight of the colleges indicated that they offered courses in data processing or computer programming that were required or recommended for draftsmen.

The question of college programs meeting the needs of industry would seem to be answered by the numbers of drafting programs and the diversity of drafting courses being offered in the junior colleges. The wide range of specialized courses in drafting supplementing the broad, general fields of engineering and production indicate an attempt to satisfy local needs and desires as expressed by local advisory committees. It might be pointed out that this factor of specialized drafting courses to meet the needs of local industries identifies the two-year college in California as a community college, unstructured by state or parent university requirements, and flexible enough to initiate innovative courses or programs to meet the changing needs of a rapidly advancing technological society, whichever way the development progresses in the environment of the particular college.

CHAPTER I

INTRODUCTION

The Problem

The problem for this study was stated in the following form: "What specialized training in drafting for automation is required by industry, and what curricular revisions in junior colleges will meet the challenge?"

The statement of the problem suggests the need for an evaluation of the drafting curriculums in junior colleges. Teachers in every field and at every level are at all times faced with the need to evaluate their instruction. Curriculums cannot remain static. They must change with the times. They must meet the needs of the students. They must satisfy the objectives for which they were developed. Teachers need to continually verify the desirability of the behavioral changes they strive to bring about in their students through their teaching. Basil Peterson found this to be the foremost problem facing the junior colleges of California in a study reported in 1965.[1] Roger Garrison in a study of issues and problems affecting junior college faculty members across the country, reported that one of the most frequently expressed needs was, "time for more advanced preparation and keeping abreast to learn what I am supposed to be teaching."[2] In stating the needs for institutional research, John Roueche cited the needs for studies of curriculum development and evaluation of instruction of in junior colleges.[3]

Evaluation of Vocational Education

Although the foregoing examples are expressions of need for evaluation of the total programs in the junior colleges without reference to any particular subject matter area or discipline, the demands for evaluation and improvement are as compelling in the vocational-technical fields as they are in the other areas of instruction. As John Gardner stated in an article titled, "Quality in Higher Education;"

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[1] Basil Peterson, Critical Problems and Needs of California Junior Colleges. California State Department of Education, Sacramento: 1965

[2] Roger Garrison, Junior College Faculty: Issues and Problems. American Association of Junior Colleges, 1967.

[3] John Roueche, "Gaps and Overlaps in Institutional Research." Junior College Journal. November, 1967.

> Excellence in plumbing is as important as excellence in philosophy. The society which scorns excellence in plumbing because plumbing is a humble activity and tolerates shoddiness in philosophy because it is an exalted activity will have neither good plumbing nor good philosophy. Neither its pipes nor its theories will hold water."[4]

Recent studies on vocational and technical education stress the need for continued evaluation of instructional programs. Samuel W. Burt, chairman of the A.V.A. Industry Cooperation Committee, as recently as September 1968, expressed this need in a list of activities recommended for advisory committees in his article, "A Three-Year Program Plan for Your Advisory Committee". One of his suggestions for committee activities was, "assisting in the development and review of course content to assure its currency in meeting the changing skill and knowledge needs of the industry".[5]

Chester Swanson presented some problems in evaluation regarding the committments to vocational education under the Vocational Education Act of 1963. In stressing the need to keep the course content related to the needs of the labor market he stated:

> Job analyses must be made and the curriculum content organized to develop the skills and knowledge necessary for success in a particular job.
>
> Curriculum development must be undertaken for each job for which training is to be given. It must be reviewed often to ascertain whether the demands of the job are changing. This means that obsolescence must be recognized in terms of equipment, skills, knowledge, and even programs and teachers.[6]

Swanson also stated that this type of job analysis and curriculum development requires the time and effort of persons with special skills and that due to this fact and to the limited market for these materials, relatively few occupational curriculums have been developed.

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[4] John Gardner, "Quality of Higher Education." Junior College Journal, May, 1968.

[5] Samuel M. Burt, "A Three-Year Program Plan for Your Advisory Committee," American Vocational Journal, September, 1968, p. 13

[6] Chester Swanson, "Can We Carry Out the 1963 Mandate for a Total Program?" American Vocational Journal, September 1968, p. 30.

Other writers before Burt and Swanson have stressed the same need for evaluation of instruction in the forms of convention reports, committee reports to the Congress, and panel reports to the President. With all the recommendations for increased evaluation, however, there have been few studies made on the heart of the matter -- the skills needed for specific job classifications. To use an analogy, the bulk of the studies have taken the "hen house approach to studying egg production" in their evaluation of vocational education programs. We have measured the buildings, described the facilities, computed the initial costs and the continuing costs. We have counted the students and the teachers, described the teachers' backgrounds; but little has been done to evaluate course contents, the skills, knowledge and appreciations of the students, or the placement and success of the students who have completed the program. We have measured the hen house, counted the nests, measured and evaluated the feed, but we don't have a very accurate count of the egg production or the quality of the eggs produced as desired by the market.

A study related to this problem of identifying workers' needs was conducted in Illinois in 1964 under the title, "Technician Need Study: Vermillion County, Illinois."[7] At that time researchers from the University of Illinois attempted to define the responsibilities of technician level workers and distinguish between the needs of technicians in the fields of mechanical, electrical-electronics and chemical technology. Technicians in industry were asked to respond to a check list of skills that were important to their job functions.

The rankings of these expressions of importance of job skills were used to identify the common needs of technicians of various types and in various fields of industry. This study of technician needs was a valuable step toward identifying skills of groups of technicians and suggests a method for further studies of duties within the groups to identify skills with sufficient clarity to serve as behavioral objectives in training programs.

Evaluation of Drafting Programs

Regardless of their felt need for evaluation and revision of their programs and the concomitant need for refreshing their own skills and surveying the changing demands of industry, few teachers can afford the time and energies required for personal participation in this type of heuristic study. A recent study of drafting jobs in

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[7] Technician Need Study: Vermillion County, Illinois, A study conducted by The University of Illinois, Urbana, Illinois, 1964.

Arizona expressed the difficulty teachers have attempting to keep up to date in their field through summer employment, as it stated:

> Nevertheless, design and drafting teachers are expected to remain reasonably up-to-date in the practices utilized in several design and drafting occupations, for example, mechanical design and drafting, architectural drafting, structural drafting, electro-mechanical design and drafting, technical illustration, and tool design. Knowledge of current practices related to these occupational areas is particularly required by teachers assigned to instruct in the basic exploratory courses in design and drafting technology and in programs where enrollment and teaching staff do not justify narrow specialization within the subject matter field.[8]

Every program in vocational-technical education is in need of regular evaluation, and the demands for revisions are mounting with each new technological discovery and each new educational experiment. However, the evaluation of curriculums for drafting programs offers some problems that may be more imminent than similar problems in other fields, and the study of drafting training at this time might help to point the way for evaluations in other fields before the problems become critical. Four distinct problems were identified that represent pressures for the evaluation of drafting curriculums, and they constituted the reasons for making this study.

First, with the increased use of programmed engineering design, computer assisted drafting, numerically controlled machine tools, and numerically controlled drafting systems, the nature of the work of the draftsman is reported to be changing. Drafting teachers need to be aware of the direction and extent of the changes that are actually taking place and keep alert to those that may be, "just around the corner."

Second, there seems to be a need for increased numbers of draftsmen to meet the demands of the labor force. The American Institute for Design and Drafting has predicted that 212,000 new draftsmen will be needed in this country by 1975.[9]

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[8] Carle E. Squires, Current Practices Observed in Design and Drafting Occupations, Glendale Community College, Glendale, Arizona, 1966, p. 2.

[9] Leslie S. Harrold in a reprint of an address titled, "The New Class of Draftsmen 1967 to 1977," presented at the meeting of the American Institute for Design and Drafting, California Council, Los Angeles, May 11, 1967, p. 4.

The third reason lies in the need to recognize drafting as a distinct area of vocational education. Engineering programs in colleges have become so science oriented and have eliminated drafting from the curriculum to such an extent that engineering majors who do not complete their degree programs are not prepared to work as draftsmen.[10] Thus a source of training that once provided many draftsmen no longer exists. Graduating engineers are no longer expected to start at the drawing board. High level design draftsmen are now needed with less than a baccalaureate degree.

The fourth problem stems from the mounting complexity of our technological society. The increased specialization of industrial fields demands specially trained draftsmen such as mechanical, architectural, electronics, civil, structural, aerospace, and others.[11] Curriculum coordinators for these drafting courses need to know which drafting skills are needed by all draftsmen and may be included in cluster courses, and which skills will require specialized drafting courses for individual options in the program.

Definition of Terms

Job skills: the things draftsmen do on the job as itemized in the check list. See Appendix B-8. These items were selected from textbooks on drafting, catalog descriptions of drafting courses, course outlines, and job analysis. They were verified through pilot studies and modified as the need for modification became evident.

Draftsmen, detailers, and designers: technicians whose major functions are drafting. The term, draftsmen, is usually understood to be a more general classification of both detailers and designers. The distinction is often made between detail draftsmen and design draftsmen. Some examples of the classifications of draftsmen will help to demonstrate the various levels of detailers and designers and their corresponding pay rates and required education and experience. Neither the job titles nor the numbers of classifications of detailers or designers will be found consistent throughout the industry, and the pay rates and education and experience do not represent the policies of any particular firm. However, the examples should be of value in distinguishing the various levels of classifications.

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[10] See college catalogs; e.g.

a. U.C.L.A. General Catalog 1967-68, pp. 96, 241.
b. California State College at Los Angeles Bulletin '65-'67, p. 188.
c. San Jose State College Bulletin, 1966-1967, pp. 123, 124.

[11] "Drafting Education Pays," Engineering Graphics, Vol. VIII, No. 1, January, 1968, p. 11.

Classifications of Draftsmen

General Classification		Pay Range $ per hr.	Education - Experience
Detailers			
C.	Tracers or Apprentices	2.00 - 2.50	High School Mechanical Drawing
B.	Detailers or Jr. Draftsmen	2.40 - 2.90	2 yrs. H.S. M.D. + 1 yr. exp. or Jr. Col.
A.	Sr. Draftsmen	2.80 - 3.30	H.S. M.D. + 3 yrs. exp. or Jr. Col. + 1 yr.
Designers			
C.	Jr. Designers	3.20 - 4.10	H.S. M.D. + 5 yrs. exp. or Jr. Col. + 2 yrs.
B.	Designers	4.00 - 4.80	Jr. Col + 4 yrs. exp.
A.	Senior Designers	4.50 - 5.00	Jr. Col. + 5 yrs. exp. or B.S. + no exp.

As the classifications of draftsmen are not consistent throughout industry and each firm or professional office used its own system, the drafting managers responsible for the selection of participants were asked to identify "middle level designers" and "middle level detailers" for the two levels of draftsmen to be sampled. This method of identifying draftsmen for the sample seemed to present less difficulty than selection on the basis of one of the systems with finer classifications; and yet it provided participants that were sufficiently consistent in their levels and functions.

Review of the Purposes

The evaluation of the curriculum for any vocational program, then, is dependent upon the regular and comprehensive study of the needs of the workers in that occupation. As new technologies affect the skills and functions of the draftsmen, the teachers of future draftsmen must be alert to the implications of the new technologies for the curriculum revisions in their programs. The purposes of this study were to provide drafting instructors and others who might be interested with information regarding the needs of draftsmen as they were being affected by automation in various fields, and to provide better understanding of the existing programs in general and specialized drafting in the junior colleges of California.

CHAPTER II

DESIGN AND PROCEDURES

Design and Pre-test of the Instruments

Subsequent to the review of literature related to computer graphics and conferences with drafting managers and drafting instructors, this study was separated into three phases of data collection. The first phase consisted of contacting the junior colleges to survey the types of drafting programs currently being offered. The second phase was the survey of draftsmen in industry to determine the effects of automation on their job functions and to study their needs for new skills or specialized responsibilities. The third phase of the study was the interviewing of drafting instructors in colleges that showed evidence of progress in providing programs that would meet industry's needs for draftsmen commensurate with the demands of new and developing technologies.

Survey forms and questionnaires were prepared for the study of the existing programs in the junior colleges, and a check list of drafting duties was developed for use as an interview schedule with draftsmen and drafting instructors. These instruments were pre-tested with the cooperation of three companies and three colleges. The companies provided a total of seventeen draftsmen and supervisors as interviewees, and the colleges providing a total of eight instructors and department chairmen who served as participants in the pilot study and offered suggestions for modifications of the instruments and the procedures for conducting the interviews. Members of the Citrus College drafting advisory committees were very helpful in their suggestions and assistance in the arrangements of the pilot studies.

Composition of the Samples of Participating Draftsmen, Supervisors, and Instructors

In the early stages of the design of this study it seemed reasonable to sample equal numbers of draftsmen and supervisors in the five areas: architecture, civil, electrical, mechanical, and structural engineering. As the study progressed it became apparent that adherence to such a plan would not produce the most realistic or representative information. The first reason for this conclusion was the knowledge that in areas such as architecture and civil engineering there would be a decidedly smaller proportion of the designers who were not graduates of four-year programs. Since the study was directed toward the preparation of draftsmen, both at the detail and design levels, by the two-year colleges it became evident that fewer designers in architecture or civil or structural engineering would be the product of the two-year college. Thus it seemed advisable to accept smaller samples of designers and supervisors in those fields.

Another factor that emerged to influence the numbers of participants in the various fields was the use of automated drafting devices. As one of the prime objects of this study was to study the effect of automation on the needs of the draftsman, it was necessary to go to the firms that were reported to be making the most extensive use of automated equipment. Those firms were reported to be mostly in the aerospace and electronics fields. Therefore, it seemed the draftsmen most likely to be affected by automation would be the mechanical and electronics detailers and designers.

As the proportions of the draftsmen and supervisors participating in the study became more heavily weighted in favor of the mechanical and electronics draftsmen, it seemed reasonable to maintain those proportions not only from the factor of use of automated devices, but also from the consideration that these fields represent the greater proportions of total draftsmen employed. Therefore, the population of the survey more nearly represents the proportions of draftsmen employed in each field of engineering and architectures, as well as a sampling of the firms reportedly using automated drafting devices.

The numbers of participants have been arranged according to field of work level of job classification.

			Supervisors of:		
	Detailers	Designers	Detailers	Designers	Instructors
Arch.	8	9	8	1	9
Civil	16	6	3	4	4
Elect.	25	40	8	8	6
Mech.	37	52	9	9	17
Struct.	11	15	3	5	4
Gen. Draft*	—	—	—	—	4
Totals	97	122	31	27	44

* Four instructors of general drafting were included in the survey because of the large number of general drafting programs reported by the junior colleges and to serve as a comparison of the emphasis ratings expressed by instructors of specialized courses.

The Survey of the Junior Colleges in California

Letters of introduction to the study and questionnaires were sent to eighty-seven public junior colleges in California in December, 1968, as identified by the State Bureau of Vocational-Technical Education. Those junior colleges that were new and may not have begun instruction in all the areas that they had planned as their initial program were also included. The deans of instruction or deans of vocational education were asked to supply information on the types of drafting programs offered, the sizes of their programs, the amount of drafting, mathematics, and related technical courses required in their drafting programs and to answer some questions regarding the changes in their programs relative to automated drafting and specialization. (See Appendix A-1, 2, 3).

By February 1, 1969, responses to the survey had been received from approximately fifty percent of the colleges. A second letter, (see Appendix A-4), and an additional copy of the questionnaire were sent to all those who had not responded to the first request, and by March 15, eighty-one colleges or ninety-three percent of those in the state had responded.

The responses to this survey were studied to determine the general nature of the drafting programs in the junior colleges and to identify the colleges that would be visited for personal interviews with instructors at a later date.

Interviews With Draftsmen in Industry

During the preparatory investigation and planning of the design for this study, informal discussions were held with members of professional drafting and design organizations, at meetings and conferences on drafting management and computer graphics. As the study developed, the members of these organizations were helpful in identifying the persons to contact in their respective companies and others that they knew to be active in the development of new techniques in drafting. Through these recommendations, thirty-five companies and professional offices (see Acknowledges) were visited and 277 draftsmen and supervisors were interviewed.

In each of the firms contacted, the persons most responsible for automated drafting were sent packets of information regarding the study including samples of the interview schedules and check lists to be used. (See Appendix B-1, 2). As soon as arrangments could be made, the firms were visited and from three to fifteen draftsmen and supervisors were interviewed. The numbers depended upon the type of company, its size, and the varieties and levels of draftsmen available for the study. A typical interview session would be conducted with eight draftsmen and two supervisors assembled in a conference room near their work stations. The desired sample at each firm consisted of two sets of participants from different fields of drafting, each set consisting of 2 detailers, 2 designers and a supervisor. (See Appendix B-3 for the instructions to the firms for the selection of participants.) These participants would have received a letter, a few days before, describing the study in general and informing them of the time, date, and place of the interview meeting. After a short introduction from the drafting manager, the director of the study would provide more information on the importance of the study, reassurances of confidentiality of the responses, and would read through the directions for the questionnaire and check list, clearing up any questions that might arise. The draftsmen would be given enough time to complete the forms, usually 20 to 30 minutes would be sufficient, and the director of the survey would help the participants with interpretations of the questions or any other problems that might arise during the session. As each participant completed the forms, the director would scan them briefly for completeness and attention to direction and informally discuss with the participant any additional information or questions that might be forth-coming from the survey procedure. In a few instances, due to absences of assigned participants from the sessions, the interview schedule forms were left with the drafting manager or supervisor who then acted as the director to assist the participant in the completion of the forms and mailed them to the director when they were complete. This was necessary for about ten different participants at four or five firms due to unforseen conflicts at the time of the scheduled interviews.

The managers, supervisors and draftsmen were at all times very cordial, cooperative, and responsive to the professional intent of the study as they realized their contribution to a research project that was designed to up-grade instruction in the drafting profession.

Interviews With Drafting Instructors

As the responses to the survey of the junior colleges were reviewed, the colleges with the most apparent progress in drafting programs were selected for personal visits with the instructors. The first consideration in identifying these colleges was the indication of student use of computer assisted drafting devices or automated drafting equipment. Next in consideration was the amount of specialization in the options for drafting programs. Those colleges that provided the most detail regarding their offerings in specialized fields were selected as very valuable sources of information on specialization in drafting. A third consideration was the location of the college. It was suggested early in the design that those colleges located near concentrations of industries that employ large numbers of draftsmen, particularly those industries that might be using automated drafting devices, would likely be influenced by the most advanced practices in industry, through their drafting advisory committees and their contacts with industry through placement and follow-up studies. Because of the very few colleges that indicated any use of automated equipment in their drafting programs, and because of the third consideration, several colleges in active industrial areas were visited even though their programs consisted only of general drafting or provided limited selection in the special options.

When the responses to the junior college survey were reviewed and the colleges to be visited were selected, letters were sent and phone calls were made to arrange visits and interviews. In some cases, particularly with colleges in distant cities, the interview forms and check lists were sent in advance of the visit in order to allow the instructors time to prepare their answers and to provide more time for informal discussions of programs and facilities or the instructors suggestions during the scheduled time of the visitation.

As with the interviews of draftsmen in industry, a few of the interviews with instructors did not take place as planned. Unforseen emergencies occurred that made it impossible to meet with some of the instructors as planned. When the interviews could not be rescheduled for a later time, the forms were left for the instructor to complete, after he had been given the information concerning the survey either personally from the director of the project or through others involved in the survey at that college. Because of such situations, ten of twelve instructors found it necessary to return their responses to the check list by mail.

When the interviews were completed and the information was assembled from the 219 draftsmen, 58 supervisors and 44 instructors, the responses were key punched and tabulated using the Autocoder system on an IBM 1401 computer to calculate the mean ratings of each item for each of the 26 groups of respondents.

CHAPTER III

FINDINGS AND ANALYSIS - SURVEY OF THE JUNIOR COLLEGES

Types of Drafting Programs Reported

As shown in Table I, of the 67 colleges that stated that they offered some form of vocational drafting program, general drafting was offered by 52 colleges, mechanical drafting by 45, structural drafting by 16, architectural drafting by 46, civil drafting by 21, electronics drafting by 31, and other specialized areas of drafting were offered by 13 colleges. The "other" drafting programs mentioned by the colleges were, "tool design," "aerospace design," "marine technology," "naval drafting," "industrial-mechanical engineering," "technical design," and "piping."

Of the 13, the only additional course offered by more than one college was technical illustration. It was decided early in the design of the study that technical illustration would not be included in this study as many colleges offer it separate from drafting and more associated with art. In industry too, the technical illustrator may be a specialist more associated with technical publications or technical writing than with drafting. There is no doubt that more schools would have reported technical illustration as a special field of drafting if it had been included with the other suggestions. This is not to say that technical illustration is not or should not be a part of the drafting program. Mention of it at this time is only to assure the reader that the inclusion of technical illustration in this study was at one time considered, but because of the border line relationship it has with drafting and because of other recent studies that have been made, it was decided not to include it in this study.

Many of the colleges, particularly the smaller ones, offered only a general drafting program incorporating in it as much experience in the specialized areas as possible. The larger colleges tended to offer the more specialized programs as would be possible with larger student enrollments and a more diversified faculty.

The significance of question one is the disclosure of the diversity of kinds of programs and fields or disciplines for drafting programs in the two year colleges. The lack of standarization of programs or the inability to identify a typical or trend situation might be disappointing to those who would like to generalize about the drafting programs in the state. However, it would seem to reflect the designs and desires of local communities as they attempt to meet the needs of transfer students, occupational preparation students and those wanting up-grading or related training in their present occupation. The fact that there is such a variety of programs makes evaluation or accreditation difficult as it becomes necessary to distinguish characteristics of programs on bases other than program titles or course titles.

TABLE I

NUMBERS OF CALIFORNIA JUNIOR COLLEGES OFFERING DRAFTING PROGRAMS OF VARIOUS TYPES

N = 67 COLLEGES*

Options	A.A. Degree Program Only	Cert. Prog. Only	Trade-Related Program Only	A.A. and Cert.	A.A. and Trade-Related	Cert. and Trade-Related	All 3 Types of Programs	Total (One Type or Another)	Available	
									Days	Nights
Gen. Draft.	19	1	8	9	3	3	9	52	46	36
Mech. Draft.	15	0	6	10	2	4	7	44	40	31
Struct. Draft.	7	1	5	2	0	1	0	16	10	5
Arch. Draft.	22	1	2	13	3	2	3	46	39	25
Civil Draft.	7	0	6	3	2	2	1	21	16	8
Elect. Draft.	7	3	13	2	1	2	3	31	22	21
Others	7	2	4	5	1	0	2	21	11	8

* Of 81 responding colleges, 67 reported some type of vocational drafting program.

In the past it was common practice to offer as a drafting program the first year or even both years of the engineering transfer program. This approach was reasonable when the engineering transfer program included eight to ten units in drafting, technical courses in machine shop and foundry practice, surveying, building construction or practical laboratory courses in electricity and electronics.

However, as the engineering transfer program has been modified to eliminate the practical courses and emphasize theory, the desirability of using many engineering courses for draftsmen becomes questionable. To complicate matters, programs with such titles as drafting technology, engineering technology and industrial technology have been introduced with various suggestions and recommendations for the types of courses to be included in such type of program.

Some schools offer only an engineering transfer program and define a draftsman as one who completes all the courses for engineers in the two-year program. This approach may be appropriate for those students who will take the first two years of the engineering program and then not transfer directly to the four-year college but enter the labor market as a draftsman and either work up to the classification of engineer through practical experience or, by attending part-time courses, eventually receiving the B.S. degree.

Other schools have maintained some of the engineering courses for the training of draftsmen, particularily the engineering drawing and descriptive geometry, and have substituted technical mathematics and technical physics for the more rigorus and theoretical engineering requirements. However, in other colleges drafting is considered only one of the many jobs for which a technician will be qualified and programs are designed along the lines of engineering disciplines such as civil engineering technology, mechanical or architectural technology or combinations such as civil-structural technology or electro-mechanical technology.

With all the foregoing possibilities for training draftsmen it is not surprising that some colleges found it difficult to respond to specific questions when their programs are designed to train students in more general occupational groups. This same confusion was found to some extent in industry where varying forms of job classification were used. Some professional offices made no clear cut distinction between civil and structural or architectural and structural draftsmen. Many companies list draftsmen as electro-mechanical and a man might be expected to perform drafting functions in either area and his title or classification might not reveal the area of his greatest capabilities nor his present assignment.

Eighty-eight programs were reported as offering certificates of completion. Some of these may be the two-year program identical to the A.A. degree requirements. Usually, however, they are thought of as the technical core of the A.A. degree program that might be completed in one year for technical competency, sacrificing the general education and other A.A. degree requirements in order to gain occupational skills sooner.

Trade related courses may vary from a few units of electronics drafting for an electronics technican or general mechanical drafting for a forestry major to an extensive map drafting and photogrametry course for civil technican, or considerable machine drafting for tool designers. While these programs and courses are not primarily designed for draftsmen and the technician who has completed the courses may have many other duties other than drafting, in many cases the technicians may be employed as a draftsman for some time on the strength of these courses. Therefore these related courses may be the only introduction a student will get to the drafting skills that may later comprise a large part of his on-the-job duties, and as such they might well be included in a discussion of vocational drafting programs.

It may be in order here to mention some other types of programs in drafting reported by some of the colleges. Several colleges listed such items as adult education courses, special skill centers and manpower development programs. While these programs may add considerably to the development of potential draftsmen, it was decided that since many of these courses may be offered under high school sponsorship or other specially funded administrations, it would be more meaningful in a study of the two-year colleges to concentrate on those courses designed for college credit and more under the influence of the college technology departments.

The high incidence of architectural drafting as compared to the other areas might be due to the broad destinction of professions which starts with the architecture-engineering distinction. Engineering is later defined in the more specialized fields of mechanical, structural, civil, etc. Students in high school and junior college often think of defining their vocational objectives by broad areas such as architecture or engineering before they decide on a particular discipline for emphasis. Thus the two general fields of engineering and architecture are distinguished as separate programs before the specialized fields of engineering are identified as objectives. This practice might also account for the large number of programs identified as general drafting without reference to a specific discipline.

At the present time, there seems to be no widely followed plan for vocational drafting programs. In some colleges it appears to be considered only as a second choice for those who drop out of engineering programs. In other colleges drafting is a part of a specialized technology program and represents only a part of the responsibilities of a technician in that field. Under still different organizational structures drafting technology is considered to be a program in itself providing general drafting skills as common to all engineering and architectural practice and incorporating sufficient specialized drafting and related shop or laboratory experience to produce cognizant design technicians in one or more specific engineering fields.

With all the variations in program structures and curriculum patterns, only a broad appreciation of the training offered at any particular college is possible. A detailed understanding would need to be formed on the basis of instructional objectives or some form of desired behavioral outcomes. A detailed understanding of a program as desired for evaluation, accreditation or certification would need to be based on more definitive analysis of course content preferably described in terms of instructional goals or desired behavioral objectives.

Enrollments in Drafting Programs

The findings from question two of the first part of the study are displayed in Table II. These compilations portray the extent of the drafting programs in the California junior colleges as defined by enrollments. Exact figures on enrollments are difficult to obtain and are often misleading. Accounting procedures vary from one college to another, and exact figures may not be available for separate fields of drafting majors or even for the number of vocational or technical students enrolled in drafting technology. For these reasons, it was deemed sufficient to obtain some general ideas of the approximate enrollments in programs by asking for a response within reasonable ranges of enrollment numbers. The fact that the results provided well distributed quantities in the various range groups would indicate that the ranges selected were reasonable.

The results of question 2 can be helpful not only in studying the attrition of students in the drafting programs, but also in roughly defining the comparable size of programs in the various fields. The largest programs reported were in general drafting, and only one college reported having over 50 students complete the program in that field in Spring of 1968.

The programs in mechanical drafting and architectural drafting were slightly smaller both in number of colleges offering the programs and in the number of students enrolled. Structural, civil, and electronics drafing were considerably smaller in both categories.

The results of the first and second questions indicate that relatively few colleges offer drafting programs in specialized fields. Even in the more general areas drafting enrollments are small. Only one college reported more than thirty students completing the program in June, 1968.

TABLE II

ENROLLMENTS IN CALIFORNIA JUNIOR COLLEGE DRAFTING PROGRAMS IN 1968 AS SHOWN BY NUMBER OF COLLEGES REPORTING ENROLLMENTS IN SPECIFIED RANGES

N = 67 COLLEGES*

	APPROXIMATE NUMBER OF STUDENTS ENROLLED IN SPRING 1968								APPROXIMATE NUMBER OF STUDENTS WHO COMPLETED IN JUNE 1968			
	1st Year Program				2nd Year Program							
	1-14	15-29	30-50	Over 50	1-14	15-29	30-50	Over 50	1-14	15-29	30-50	Over 50
Options	Number of colleges				Number of colleges				Number of colleges			
Gen. Draft.	5	15	10	17	15	9	3	6	20	12		1
Mech. Draft.	14	14	6	6	16	8	8	2	22	4		
Struct. Draft.	5	6			8	1			6	1		
Arch. Draft.	8	13	12	8	16	12	3	1	15	15		
Civil. Draft.	7	7			10	2	1		11	1		
Elect. Draft.	5	5	2	2	8	3	1		6	3		
Others	1	11			3	7	1		9	2		

* Of 67 colleges reporting drafting programs, 7 colleges had no figures available for enrollments in specific options.

Specialized Drafting Courses Recently Added

The third question, "Has your college added any specialized drafting courses in the last 3 years?" was asked to learn:

1. What changes were taking place in the drafting program that might suggest increased emphases on vocational drafting, as separate from drafting for the engineering transfer program.

2. How many junior colleges were offering courses in computer aided drafting or drafting for numerical control under various titles.

3. What new fields of drafting were being introduced.

The results of this question showed that 33 of the 67 colleges had added new drafting courses. It was interesting to note that several of the colleges had been in operation less than 3 years and some stated, "Yes, all our courses are new." Others said, "No, our program is too new to add new courses." So one might assume that about one half the colleges have indeed added some new courses to their drafting program.

Only one college reported the addition of computer drafting, and none reported any course in drafting for numerical control.

The courses reported as having been added in the last three years and the number of colleges reporting each were as follows:

Electrical or electronics drafting	7
Technical illustration	6
Tool drafting	4
General drafting technology	4
Civil drafting	3
Mechanical drafting	3
Computer drafting	1
Structural drafting	1
Specifications writing	1
Aircraft master layout	1
Blueprint reading for marine technicians	1
Sheet metal drafting	1
Optics drafting	1

Mathematics Prerequisites

The data with regard to mathematics prerequisites for drafting are found in Table III. One of the characteristics often used to distinguish technical education from vocational education or to distinguish engineering technology from industrial technology has been the level of mathematics required in the training. The work of the draftsman is sometimes assumed to be a technical job, requiring mathematic through

TABLE III

NUMBERS AND PERCENTAGES OF THOSE COLLEGES OFFERING SELECTED TYPES OF DRAFTING PROGRAMS THAT REQUIRE SPECIFIED LEVELS OF MATHEMATICS AS PREREQUISITES TO THE PROGRAMS

				MATHEMATICS COMPETENCIES REQUIRED								
Option	N^1	No Response	N^2 and %	None	Tech. Math.	Alg.	Geom.	Adv. Alg.	Trig.	Other	Basic Math.	Gen Math.
Gen. Draft.	52	4	48	20 42%	12 25%	5 11%	3 6%		4 8%		3 6%	1 2%
Mech. Draft.	44	2	42	16 38%	14 33%	4 10%	4 10%		3 7%		2 5%	
Struct. Draft.	16	4	12	2 17%	4 33%				3 25%	1 8%	2 17%	
Arch. Draft.	46	2	44	13 30%	14 32%	4 9%	7 16%	1 2%	4 9%		1 2%	
Civil Draft.	21	3	18	4 22%	4 22%	1 6%	1 6%		6 33%		2 11%	
Elect. Draft.	31	5	26	4 16%	7 28%	5 20%	1 4%	2 8%	3 12%	1 4%		3 12%

N^1 = Number of colleges reporting the specified drafting programs. See Table I.
N^2 = Number of colleges responding to question 4

trigonometry and even by some to require some calculus. At the same time some drafting positions require greater emphasis on the techniques of line work and lettering, more understanding of materials and processes of manufacturing and competency with mathematics only as far as simple algebraic calculations with fractions and decimals.

The results of question four would indicate to some extent the varied positions taken in the mathematical needs of the draftsman and the position of the junior college on the prerequisites. Many schools consider it impossible to declare a prerequisite for any California public junior college program because of their obligation to accept as students all those 18 years of age or over and all high school graduates so long as they are able to profit from instruction. With obligations such as these, the junior colleges set up programs requiring high school mathematics, hoping that through sufficient articulation with high school teachers and counselors, students will come into the program with the desired preparation. However, the instructors and counselors know that there will be students applying for admission to the college and enrolling in the technical courses who have not had the desired preparatory experience. For these students it is necessary to offer the beginning drafting courses and high school level courses in mathematics. These courses are often concentrated to cover a year of high school work in one semester with the idea that the students are more mature and more prepared to study than they were in high school.

The large number of responses indicating no prerequisites would seem to reflect the practical viewpoints of some teachers and administrators in not declaring an absolute prerequisite because they know that they must enable students who have not had the desired prerequisites to make them up either before or along with their courses in drafting.

The seemingly rigorous prerequisite of trigonometry as a requirement for entering a drafting program probably reflects the position of those junior colleges that offer drafting as a part of the engineering transfer program only. At these colleges a student would take descriptive geometry or graphics in his first year and trigonometry would be a reasonable prerequisite. The same attitude is observable in the architectural drafting requirements as schools set up their programs to include enough transferable work to enable students to continue to the four-year colleges with as much credit as possible.

It will be noted that the total of the percentages for any of the programs is greater than 100 percent. In answering this question, as some of the respondents checked both technical mathematics and trigonometry presumably indicating that either would satisfy as a prerequisite, both responses were tabulated. Other responses for prerequisites in mathematics that were written in were "general mathematics," "basic mathematics," and "placement on a mathematics test."

The responses to question four again point out the varied viewpoints on the need for mathematics in the training of draftsmen and the flexibility of programs designed by local colleges to meet the needs of their particular communities.

Mathematics as a Part of the Drafting Program

Somewhat as an extension of question 4, question 5 was asked to learn what mathematical competencies were included in each field of drafting training.

The original draft of this question asked which mathematics courses were included in the training programs. The pretest of this instrument pointed out that many programs are offered as a single block of 10-15 units and students do not take the mathematics courses under their usual titles, but are given the mathematical experiences they need along with the drafting. For this reason, the term mathematics competencies was used in an attempt to identify the experiences included regardless of the name or structure of the offering.

It will be noted in Table IV that approximately half the programs required technical mathematics with a little less than half requiring trigonometry. There did not appear to be any great differences in the requirements for the various fields of drafting except that civil and electronics drafting require trigonometry by a larger proportion of colleges and calculus is required for structural drafting more than it is for other fields. It might be of interest to note that analytic geometry and calculus were required in a very small percentage of the programs although some current writers are stressing the need for mathematics at these levels for computer graphics and numerical control.

Some college drafting programs are described as mechanical drafting, 15 units, or architectural drafting, 12 units, and the entire drafting program in one area is taught as a block. Within this block there may be many experiences in such topics as geometric constructions, right-angle trigonometry, or problems applicable to structural or civil engineering without the identification of these experiences as courses. For this reason it is difficult to compare programs or generalize about them on the basis of traditional course titles. Moreover, as some schools are offering mathematics courses designed to incorporate more modern mathematic concepts the more analytical theories for science and engineering and de-emphasizing the applications and constructions so meaningful to the draftsman, it is not always possible to identify the mathematical concepts to which a drafting student has been exposed by reviewing the catalog course names and course descriptions. Further study in greater detail of the course objectives, cintent and emphasis would be needed to adequately describe a school's offering.

TABLE IV

NUMBERS AND PERCENTAGES OF THOSE COLLEGES OFFERING SELECTED TYPES OF DRAFTING PROGRAMS THAT INCLUDE SPECIFIED MATHEMATICS COMPETENCIES IN THEIR PROGRAMS

Option	N^1	No Response	N^2	MATHEMATICS COMPETENCIES INCLUDED							
				None	Tech. Math.	Alg.	Geom.	Adv. Alg.	Trig.	Analy Geom.	Calculus
Gen. Draft.	52	5	47	7 15%	26 55%	7 15%	6 13%	6 13%	15 31%	2 4%	1 2%
Mech. Draft.	44	5	39	3 8%	19 50%	8 20%	8 20%	5 13%	17 23%	1 3%	0
Struct. Draft.	16	3	13	1 8%	5 39%	1 8%	1 8%	1 8%	2 15%	1 8%	3 23%
Arch. Draft.	46	5	41	3 7%	19 46%	8 20%	9 22%	6 15%	16 39%	3 7%	1 2%
Civil Draft.	22	3	19	1 5%	8 41%	2 10%	1 5%	2 10%	9 47%	2 10%	1 5%
Elect. Draft.	31	8	23	3 13%	7 30%	7 30%	3 13%	4 17%	9 40%	0	1 4%

N^1 = Number of colleges reporting the specified drafting programs. See Table I

N^2 = Number of colleges responding to question 5.

Prerequisite Drafting Courses

Question six was asked in order to determine what prerequisites in drafting were required for the various vocational drafting programs. As shown in Table V approximately forty percent of the colleges required one year of high school mechanical drawing as prerequisites to the various drafting programs. About twenty percent required two years of high schoolmechanical drawing. Only five programs had a prerequisite of high school architectural drawing and only one college required high school electronics drafting.

Some comments written on the returned questionnaires indicated in effect that the prerequisites were desirable and necessary for the student to complete the program in the scheduled time, but that students would be accepted into the program without the prerequisites, and beginning courses were available for those who were not sufficiently prepared in drafting from high school.

This question is important from the standpoint of articulation with high schools as students who have had one or two years of valuable drafting experience in high school should not be made to start with beginning drawing in college. However, many students may be unable to take mechanical drawing in high school for various reasons including the following: courses not offered or not included in an academic program for college preparation, or student's lack of interest or knowledge of the importance of the subject. These students should have the opportunity to take the beginning drafting courses without college credit; but to complete the program they should expect to need more than the two years required of students who come into the program with the better preparation.

The responses shown in Table V would indicate that colleges tend to require some high school preparation for the vocational-technical program in drafting. This practice not only assumes a higher level approach to the college program, but it recognizes the merits of high school drafting programs, and encourages high school vocational drafting students to continue their training with college level drafting technology.

Drafting Courses Included Under Specific Programs

Question seven of the survey asked the number of units of specific drafting courses required in the six most common drafting programs. The responses to this question show the tendencies to specialize and offer training in depth in certain fields and the tendencies to provide broader training in other fields.

Table VI should be read as follows: twenty-five percent of those colleges with general drafting programs required 1 to 2 units of mechanical drawing, twenty percent required 3 to 5 units, twenty-eight percent required 6 to 9 units and eight percent of the colleges

TABLE V

NUMBERS AND PERCENTAGES OF JUNIOR COLLEGES REQUIRING ASSORTED HIGH SCHOOL DRAFTING COURSES AS PREREQUISITES TO THEIR DRAFTING PROGRAMS

				PREREQUISITES					
Options	N^1	No Response	N^2	None	1 yr. H. S. Mech. Draw.	2 yr. H. S. Mech. Draw	H. S. Arch. Drafting	H. S. Elect. Drafting	Other
Gen. Draft.	52	2	50	27 54%	20 40%	3 6%			
Mech. Draft.	44	6	38	16 42%	16 42%	6 16%			
Struct. Draft.	16	2	14	7 50%	4 28%	3 22%			
Arch. Draft.	46	3	43	13 30%	17 40%	10 23%	2 5%		1 2%
Civil Draft.	22	3	19	8 42%	8 42%	3 16%			
Elect. Draft.	31	5	26	10 38%	11 42%	4 15%		1 4%	

N^1 = Numbers of colleges reporting the specified junior college drafting programs, see Table I.
N^2 = Numbers of colleges resonding to question 6.

TABLE VI

PERCENTAGES OF CALIFORNIA JUNIOR COLLEGES WITH DRAFTING PROGRAMS REQUIRING SPECIFIED NUMBERS OF UNITS OF EACH OF THE DRAFTING COURSES IN SELECTED DRAFTING PROGRAMS

		COURSES									
Options and Ranges of Units	N[1]	Mech. Dr.	Eng. Dr.	Desc. Geom.	Adv. Eng.	Arch. Dr.	Str. Dr.	Civ. Dr.	El. Dr.	Tech. Ill.	Art
Gen. 1-2	41	25	25	38	13	5	18	18	18	5	10
Dr. 3-5		20	40	30	25	8	5	5	15	8	8
6-9		28	3	3	13	15			5	5	
10-15		8				3				3	
over 15											
Mech. 1-2	26	11	11	19	3		3	3	3	3	
Dr. 3-5		20	17	20	8	5	3	3	11	8	
6-9		14	8		5	3					
10-15		5			3						
over 15		14									
Str. 1-2	6	33	33	17					17		
Dr. 3-5		33		17	33		50	33			
6-9		17			17		17				
10-15											
over 15											
Arch. 1-2	31	10	3	10			7	3			
Dr. 3-5		16	7	22	3	22	13			10	13
6-9		13			3	25					3
10-15		3				29					
over 15						22					
Civ. 1-2	14	29	7	29		14	14	14	7		
Dr. 3-5		29	29	3	7	14	7	36			
6-9		7			7	7		14			
10-15											
over 15											
El. 1-2	14	14	21	14					14		
Dr. 3-5		50	7			14	7		36	21	
6-9		7							36		
10-15											
over 15											

[1] = Number of colleges reporting the units of specified courses required in drafting programs under the various options.

required 10 to 15 units of mechanical drawing.

Mechanical drafting and architectural drafting were the only fields in which colleges reported offerings of over 15 units in a specialized area. This would indicate considerable specialization in these areas at the particular colleges. However, the mechanical drafting option might well include instruction in some of the other areas even though specific courses were not defined as part of that option.

The application of the traditional courses in engineering drawing, descriptive geometry, and advanced engineering drawing to the specialized options might indicate the appreciation of fundamentals and theory applicable to the various disciplines. It might also be indicative of the hopes of colleges to provide as many units of transferable work as possible to encourage students to continue on to the four-year college.

The relatively few specialized drafting programs offering more than nine units in a specific area together with the large number of programs offering courses in several areas for a specific option would indicate an emphasis on breadth rather than depth or at least breadth as well as depth.

It might be interesting to point out some of the apparent inconsistencies of the data in the table. One would be that of the 46 colleges reporting a program in architectural drafting in question one, only 31 colleges reported courses in architectural drafting in question seven. It is possible that this fact results through the attempts of many colleges to offer a program in architectural drafting that would satisfy the requirements for a transfer program to four-year colleges in architecture. Some of the articulation agreements with four-year colleges make it most advantageous for the student to take only engineering drawing, descriptive geometry, some art courses and the mathematics and general education requirements at the junior college. Specialized courses in architectural drafting in many cases will not be recognized by the four-year colleges so the junior colleges offer and suggest to the student only the courses that will transfer with the most credit.

Related Courses in the Drafting Programs

The results of question eight, in Table VII, showed the numbers of colleges that included courses in various related subjects and the distribution of units required in each related subject for the specified options.

It will be noted that the related courses were required most in the general drafting programs. Mechanical drafting options and structural drafting options required machine shop or metals courses and physics to a greater degree than they required any of the other related courses. Architectural drafting and civil drafting options made

TABLE VII

NUMBERS OF COLLEGES REQUIRING SPECIFIED RANGES OF UNITS OF RELATED COURSES FOR THE SELECTED DRAFTING PROGRAMS
N = 67 COLLEGES

Options and Ranges of Units	N^1	COURSES Mach. Shop or Metals	Matls. Lab.	Surveying	Physics	Chem.	Indus. Processes	Others
Gen. 1-2	34	3	5		1	1	4	2
Dr. 3-4		13	11	9	13	7	6	1
5-6		5	1	1	5			
Over 6		1			4			3
Mech. 1-2	24	3	2				3	2
Dr. 3-4		7	5	3	9	3	4	1
5-6		5			4		2	1
Over 6		2	1		4			2
Str. 1-2	5	1					1	
Dr. 3-4		1	1	1	2		1	3
5-6		2		1		1		1
Over 6					2			
Arch. 1-2	26	1	4	2			1	1
Dr. 3-4			5	10	6	1	2	2
5-6		2	2	2	1			1
Over 6					5			1
Civ. 1-2	22	1	2				1	
Dr. 3-4		1	2	4	5	2	2	1
5-6		1	1	4	2	1		1
Over 6				4	4			
El. 1-2	8	1	2		1		1	
Dr. 3-4		2	1		3	2	2	
5-6		1		1	1	1		1
Over 6					1			1

*N^1 = Number of colleges reporting the units of specified related courses required in drafting programs under the various options.

greater use of related courses in materials and surveying than other options did, and showed more interest in more units of physics. In electronics drafting programs, physics was required more than any other related course.

Chemistry was reported as required in a drafting program by less than twenty percent of those reporting. Therefore chemistry seems to be the least required of any of the related courses suggested. The only "other" related courses written in for more than one program were "technical mathematics," 7; and "strength of materials," 4. (The requirements of technical mathematics was covered under question five.)

It was hoped that this question might elicit some responses suggesting the need for data processing or computer programming as related to the drafting program, but no mention was made of any automated equipment in the write-in responses.

Of the nineteen colleges that failed to provide any figures in response to this question, four placed checks in the blanks but did not give the numbers of units required. Two others indicated that none were "required," or that some choice was up to the student.

The replies to question eight included a few modifications of column headings to indicate technical physics or physical science with chemistry and physics combined. Since the levels of these courses were not specified in the questionnaire it would be impossible to determine whether the courses included in any program were engineering physics or general or technical physics. The more precise understanding of the levels included in the programs would be important for the design of a program, but the more general appreciation of the subject areas included in the various programs was deemed sufficient for the purpose of this study.

Introduction to Engineering Courses

During the development of the design of this study it was suggested that the draftsman should be introduced to the total plan of scientific research, development and production in order to appreciate his position on the team of scientists, engineers, technicians, skilled and unskilled workers in the developing complexities of an automated technical society. One of the ways in which colleges might expose draftsmen to this appreciation would be through an introduction or orientation course. For this reason the colleges were asked in question nine, "Are drafting majors required to take a course in introduction to engineering or professional practices?"

Of the 67 colleges responding to this question, 19 said, "Yes" and 48 said, "No." Of those 19 that offer such a course, 12 used the title "introduction" or "orientation" to engineering and the other seven used similar titles. Of the nineteen offering such a course, 9 granted it one unit of credit, 8 granted it two units and 2 respondents failed to state the number of units granted for the course.

Drafting Courses for Numerical Control and Computer Graphics

Question 10, regarding offerings in "drafting for numerical control,' 'computer-aided drafting,' 'data processing,' or other specialized courses," was posed in an attempt to learn of any specific courses related to automation being offered for draftsmen. Only eight of the colleges stated that they offered such a course, fifty-nine indicated they did not. Those courses that were listed or offered are shown below with the number of times each was mentioned:

Introduction to data processing	5
Computer programming (Fortran)	3
Computer graphics	1
Numerical Control for the Technician program	1

Seven of the colleges that stated they did not offer such a course, stated that they did, however, include numerical control in advanced drafting courses. Two of the colleges indicated that they were developing plans to offer a course in computer graphics.

Work Experience and Work Study Programs

Question eleven on work experience or work study programs for training draftsmen on the job was asked in order to learn the extent to which this type of training was being used by the two year colleges. Of the sixty-seven respondents, seventeen replied that they had some program of this type. Of the seventeen colleges that indicated they had such a program, twelve gave figures on the numbers of students participating in them, five did not. Nine colleges indicated that less than 10 students participated in their programs, one said 12 students, one said 50, and one said 60 students participated in the program at that college. The results of this question would indicate that while only three colleges have work experience programs that might involve as many students as a class, other colleges are experimenting with this form of training with smaller numbers of drafting students.

Several respondents indicated that although they had no formal work programs, many students did work part time in drafting jobs. To the question about time spent on the job, nine reported 20 hours or more per week. The others suggested a variety of lesser times or failed to give any figures. A variety of times was also given for the number of hours spent in the classroom accompanying the work experience programs. The majority of the responses indicated a program of ten to fifteen hours per week in the classroom.

Advisory Committees for Special Drafting Options

The use of trade advisory committees is one measure of a college's efforts toward meeting the needs of industry and keeping its vocational programs up to date. For this reason question twelve was asked to determine the numbers and kinds of drafting committees currently established by colleges to assist them with their drafting programs.

Of the sixty-seven colleges reporting, nineteen had no drafting advisory committee. Some of the thirty-five that had general advisory committees also reported one or more special drafting advisory committees or special sub-committees. The areas listed most frequently for special drafting advisory committees were; architecture, 9; electronics, 5; mechanical drafting, technical illustration and engineering, each 4; and engineering technology, structural drafting and civil drafting each by 3 colleges. Those special drafting advisory committees mentioned by only one college each were specification writing, tool design, and marine technology.

Student Use of Automated Drafting Devices

As an aid in determining which colleges to visit for a sruvey of innovated programs in computer aided drafting, question 13 was asked in the questionnaire sent to all the public two-year colleges in California. This question was designed to identify those colleges that provided educational experiences of one form or another in the selected types of equipment currently described in articles on automated drafting. The results of this question are shown in Table VIII.

Of the sixty-seven colleges offering drafting programs, thirty-eight indicated that they currently provided none of the experiences listed in the question. Several, however, added that they were hoping to obtain computer assisted plotters or some piece of numerical control equipment in the near future.

One college reported having students use a light pen and digitizer, and see a plotter used on campus. Two other colleges reported that on campus the students use the plotters only. Two colleges reported some use of digitizers and plotters by students off campus. An additional nine colleges reported that students see one or another of these computer graphics items used off campus.

Regarding the use of numerically controlled machine tools, seven colleges reported that students used this type of equipment on campus and another seven reported that students see it used on campus. Eight other colleges reported that students see this type of equipment used only off campus.

Two colleges reported student use of microfilm cameras, readers and printers on campus. Five other colleges reported that students

TABLE VIII

NUMBERS OF COLLEGES REPORTING VARIOUS TYPES OF EXPERIENCES WITH AUTOMATED DRAFTING DEVICES FOR STUDENTS IN THEIR DRAFTING PROGRAMS

N = 19 Colleges*

Devices	Students Use It Themselves		Students See It Used		Other Comments (Near Future)
	On Campus	Off Campus	On Campus	Off Campus	
Computer aided cathode ray tube and light pen system	1			3	
Computer aided plotter	1	1	3	9	3
Digitizer	1	2		7	
N/C machining tools	7	1	8	11	1
Tape puncher	6		6	9	1
Microfilm cameras	3		2	7	1
Microfilm readers	7		2	7	1
Microfilm printers	5		1	5	1
Other items:					

*Of the 67 colleges reporting vocational drafting programs, only 19 described any experiences in automated drafting devices for the students.

use one or two of the items on campus. Two colleges reported that students see microfilm readers used on campus; five others reported that students see microfilm equipment used off campus.

As Table VIII shows, computer graphics equipment is in use by students at only one or two colleges. Numerically controlled equipment is used by students in roughly ten percent of the colleges. Microfilm equipment is used a little less.

Some effort is being made to enable students to see this equipment or use it off campus, but generally only ten to fifteen percent of the colleges are providing this type of experience.

Undoubtedly the cost of automated graphics equipment is a significant factor in it use for college drafting programs. As the equipment becomes less expensive, more schools will no doubt include some of it in their programs. The extent to which this equipment is used by draftsmen may be as significant a factor since there does not seem to be a great demand for it on the part of advisory committees as shown in the response to question 17.

Field Trips to Observe Automated Drafting Equipment

Question fourteen, "What use is made of field trips to industries to see or use the equipment in question 13," was asked in an attempt to elicit responses regarding the importance of automated drafting equipment if there were any that had not been brought forth in any of the other questions. The replies to this question with the numbers of colleges so responding were as follows:

No answer		17
"None," or little use indicated		21
Some use indicated		29
Once or twice a year	7	
More than twice a year	4	
Some use indicated but not otherwise specified	18	
Totals		67

Several of the respondents described field trips to specific companies that either made or were using automated drafting devices. Some respondents told which classes or groups of students were involved with specific field trips. A few designated some professional associations that had sponsored or assisted with the planning of the trips. The fact that more than one-third of the colleges had arranged field trips for their students to see automated drafting equipment would indicate that the colleges are certainly aware of the existence of the new techniques and that there is a considerable attempt to keep informed regarding industry's use of new devices.

Work Experience Programs in Automated Drafting

An attempt was made to determine what contacts with automated drafting devices the colleges might be providing for drafting students through work experience programs. Question fifteen asked, "What work experience programs provide training in the use of the equipment in question 13?" Only four colleges responded positively to this question; the others either replied, "none" or failed to answer the question.

As there were only twelve colleges with work experience programs as evidenced in question eleven, it is not surprising that so few provided any experiences in automated drafting. Placement of students in work experiences situations must necessarily be arranged with cooperating companies without regard to their use of automated equipment or the experiences with these devices that they might be able to provide to the students.

The four responses to question fifteen were:

"Some training in all programs"
"Technical drafting"
"Manufacturing processes"
"Computer programming."

These responses would seem to indicate that drafting students were not being exposed to automated drafting equipment to any significant degree through work experience programs. Interviews with the draftsmen themselves later in the study would indicate that student draftsmen were probably exposed to automated equipment as much as full time employees, as very little use of it was being made by draftsmen.

Plans for New Drafting Courses

Up to this point the questionnaire dealt exclusively with programs currently in practice. With the thought that due to automation there may be some new programs or changes to existing programs being planned for the near future, question 16 asked, "What plans do you have for new offerings in drafting?"

In response to this question, of the sixty-seven colleges reporting drafting programs, thirty-nine replied that they had no plans for new offerings. Of the twenty-eight colleges that indicated some plans, five replied that they had plans for "many"changes but did not identify any of them.

Among the more specific responses, three colleges indicated plans to add a course in computer aided graphics, and two colleges plan to add drafting for numerical control. These responses may be viewed as the amount of effect that automation is having on the plans for new courses or programs in drafting in the two year colleges. However, it must be kept in mind that there may be changes in the contents of particular courses now being taught to include instruction in or about automated drafting as was suggested in the responses to question ten.

A review of the specific areas of changes planned showed that colleges intend to add the specialized areas that are listed below with the number of colleges indicating plans for each type of change.

Structural drafting	4
Architectural drafting	3
Civil technology	2
Industrial Drafting Practices	2
Electronics drafting	1
Electro-mechanical drafting	1
Map drafting	1
Oceanographics	1

Suggestions of broader changes in the drafting programs included plans for initiating a drafting technology major by three colleges and a first year "core" program with second year options in specialized fields by two other colleges.

Suggestions From Advisory Committees

If the local trade advisory committees have suggestions for the up-dating of vocational drafting programs, one indication of needs in drafting would be a compilation of the suggestions of these committees throughout the state. If drafting advisory committees were making the same recommendations to a significant number of colleges, other colleges might also profit by testing their own programs with these suggestions.

In an attempt to learn of any patterns of suggestions that might reflect the effects of automation or the needs for specialization in drafting, question seventeen asked, "What recommendations have been made by your drafting advisory committee that will change your programs in the near future?"

A review of responses to this question showed that twenty-three colleges indicated some recommendations from their advisory committees. Five of these colleges indicated that the recommendations were too numerous to list or had been incorporated into the program, but they failed to provide any specific information as to the nature of the recommendations. Of the eighteen colleges that provided some specific responses, five indicated some type of interest in automation even though it was only to "explore" data processing and computer aided design for draftsmen or to provide more guest lecturers in these areas.

The only responses that indicated suggestions for specialized areas were from two colleges that had recommendations from their committees to drop their architectural drafting programs. Two other colleges indicated recommendations to concentrate on basic drafting and leave the specialized training to industry.

While these last two general types of suggestions from advisory committees might seem to be detrimental to the expansion of drafting programs, they might represent only a caution from industry to be prudent about trying to offer courses in areas that are too highly specialized, particularly at the expense of drafting fundamentals and basic skills.

Placement and Follow-up

Early in the consideration of criteria for the evaluation of vocational drafting programs, the question of placement and follow-up was suggested as significant in that these activities might indicate some practices used in contacting industries and keeping up with their needs. If the instructor is regularly communicating with industries as to their employment needs and getting information returned from the former students that have been placed in drafting jobs, he should be able to obtain valuable suggestions on the effectiveness of his training program.

To the first part of question eighteen, "Is instructor expected to contact industries for placement of students," 35 of the 67 colleges replied, "Yes," 32 replied, "No." To the question, "Do you have a placement counselor other than instructors or education counselors who work with industry personnel to place students," 45 colleges replied, "Yes," 22 replied, "No."

The third and fourth questions in this group asked who had the most responsibility for placement and follow-up of students. The following list shows the general catagories of replies with the numbers of colleges so responding.

	Responsibility for:	
	Placement	Follow-up
Instructor	33	18
Placement counselor	12	14
Students	11	-
Department chairmen or Deans	5	21
General counselors	3	5
Visiting industrial personnel	3	-
No answer	3	1

In response to the questions about follow-up cards and letters, 31 colleges indicated that they used such a form; 34 indicated that they did not; 2 respondents did not answer this question. Of those 31 colleges that used follow-up forms, 28 replied that they also received some information on the effectiveness of their programs in this way.

A review of the responses to this question would indicate that in about one-half of the colleges that have drafting programs the instructor has the major responsibility for placement of the drafting students. In approximately one-fourth of the colleges the instructor has the responsibility for follow-up of the students. If the information obtained by the counselors, department heads or others is forwarded to the instructor, it would seem that he might be able to receive valuable suggestions for the up-dating of his program. It appears that placement and follow-up contacts with industry are used sufficiently by the instructors to warrant the consideration of such contacts by other instructors interested in porgram evaluation.

The Use of Brochures to Describe Special Programs in Drafting

If the effects of automation on the needs for draftsmen in industry has produced significant demands for reorganization of drafting training, the brochures produced by the colleges for information to prospective students and the community as a whole should reflect not only the latest curricular changes but also the anticipated revisions that indicate the latest plans of the colleges.

In response to question nineteen, 45 of the 68 colleges replied that they did have brochures describing their drafting programs. Of the forty-five that had brochures, thirty indicated that their brochures described the special options. It might be well to note that of the fifteen colleges stating that their brochures did not describe special options, only eight offered separate options; the others could not describe special options as their program consisted of only a single area of drafting.

In regard to the effects of automation on drafting programs, only three of the colleges with drafting brochures stated that their brochures made any reference to automation. It would appear from the results of this question that automation has not yet had any great effect on the drafting programs in two-year colleges or it would be manifest in their brochures for public information.

Drafting Programs for Students with Special Needs

One of the common fears regarding automation is that it will displace workers from their jobs and require them to seek retraining. It would seem reasonable that if draftsmen were being displaced in any particular field of engineering or production, they might well seek retraining in a related area of drafting in order to make the best use of their present skills. It was hoped that question twenty would elicit responses from colleges experiencing a need for retraining displaced draftsmen if there were any such problems.

In answer to the question, "Do you offer any programs in drafting for students with special needs, ie., retraining remedial work, physically handicapped," only eleven colleges replied, "Yes." Of those eleven colleges, six listed courses in remedial mathematics, remedial reading, or beginning mechanical drawing. Two colleges reported having special equipment or tables for handicapped draftsmen. One reported a community adult training center for vocational rehabilitation.

From the responses to question twenty, there did not appear to be any concern for the need for retraining draftsmen from one field of work to another. If anything, it would appear more likely that persons displaced from other jobs are being retrained as draftsmen.

CHAPTER IV

FINDINGS AND ANALYSIS -- SURVEY OF THE DRAFTSMEN AND INSTRUCTORS

Characteristics of the Draftsmen

The cover sheet of the interview check list for the draftsmen contained some questions designed to provide information on the personal characteristics of the draftsmen. The name of the company, and the name and classification of the draftsman were needed for the tabulation of data and general record keeping operations of the study. The length of time the draftsman had spent in his present job classification was asked in order to ascertain that each participant was sufficiently familiar with the needs of draftsmen to qualify for the study. Questions regarding their educational background were asked in order to learn more about the training the draftsmen has pursued, and the importance of the junior college in their job preparation.

An insight into the characteristics of the draftsmen interviewed was obtained from the compilation of the responses to the personal information on the cover sheet of each check list used in the interviews. (See Appendix B-5.) The cover sheet was not a part of the check lists for either the supervisors or the instructors. The distribution of ages of the draftsmen interviewed was found to be as follows:

Age Range	Number of Draftsmen
Under 20	1
20-24	23
25-29	46
30-34	40
35-39	43
40-44	32
45-49	15
50-54	8
55-59	4
Over 59	0
Ages not given	7
Total	219

Responses to the personal information by the draftsmen interviewed revealed that 210 were male, and 9 were female. In response to the question asking the number of years the draftsmen had held his present classification, the data indicated that the lengths of time ranged from less than one-half year to twenty-five years. The mean of the lengths of time reported was 4.3 years in the present classification.

Training for Present Job

The draftsmen were asked to provide some indication of the training they had had for the drafting jobs they held at the time of the interviews. In order to include the earliest preparations they were asked to write in their majors in high school and the number of years of high school drafting. The following displays show the distribution of high school majors reported and the numbers of years of high school drafting reported:

Major in High School
Number of responses = 193

Major	Percent of the Responding Draftsmen
General	22.1
Academic	21.1
Drafting	15.3
Mathematics or Science	14.2
Industrial Arts	9.0
Engineering	4.3
Vocational-Technical	3.2
Art	3.7
Others	
Total	99.7

Number of Years of High School Drafting
Number of responses = 199

Years	Percent of the Responding Draftsmen
No drafting in high school	23.0
½	2.5
1	21.0
2	27.0
3	12.5
4	12.0
5	.5
6	1.0
Total	99.5

In an attempt to learn the contributions of the two-year colleges for the preparation of draftsmen, those interviewed were asked to state their majors in the two-year colleges, if they attended one, and how many years they attended such a college. The list of majors and years of attendance shows the influence of junior college drafting programs on the preparation of draftsmen. Those who indicated some attendance at a junior or community college numbered 153, of whom 117 reported the number of years of attendance.

Major in Two-year College

Number of responses = 153

Major	Percent of the Responding Draftsmen
Engineering	36.5
Drafting	19.6
Math or Science	7.9
General or Liberal Arts	7.2
Architecutral Drafting	5.2
Industrial Arts	3.3
Technical Illustration	3.3
Electronics	3.3
Business	2.6
Data Processing	1.9
Other	5.9
Foreign Two-year college	2.4
Total	99.0

Number of Years in Attendance at a Two-year College

Number of responses = 117

Years	Percent of the Responding Draftsmen
½	3.4
1	26.5
2	47.0
3	16.2
4	4.2
5	1.7
6	.9
Total	99.9

The influence of the technical institute on the preparation of the draftsmen interviewed was shown by sixty-six of the participants who stated their major and number of years in attendance at such a school. Of the 66 participants, 53 reported the number of years of attendance.

Major in a Technical Institute

Number of responses = 66

Major	Percent of the Responding Draftsmen
Engineering	27.0
Drafting	21.0
Architectural Drafting	12.0
Electronics	9.0
Tool Design	8.0
Foreign Institution	6.0
Other Majors	13.5
Majors not given	3.0
Total	99.5

Number of Years in Attendance at a Technical Institute

Number of responses = 53

Years	Percent of the Responding Draftsmen
½	13.2
1	9.4
2	53.8
3	5.7
4	9.4
5	1.9
6	5.7
7	-
8	1.9
Total	100.0

In response to other questions on the cover sheet, 19 draftsmen indicated that they had received some of their training through correspondence schools. Military service schools were reported by 25, 13 of whom listed various types of technician training, 10 identified a drafting or engineering training course, and 2 claimed computer technology training in the service. On-the-job training was reported by 58 draftsmen with a variety of titles for the training and varying lengths of times for the experiences provided.

The Supervisors' Responses on Automated Drafting

As one indication of the effects of automation on the needs for draftsmen, the supervisors were asked to complete a questionnaire that served as a cover sheet to their check list. Of the 34 companies visited, supervisors at 14 reported some type of computer or automated drafting device in the firm. At 20 companies, the supervisors reported none. Other contacts made it known that at some of these 20 companies there was some type of automated equipment, but it was not used in the drafting function sufficiently for the supervisors to know about it or feel that it is a part of their plant. For example, terminals for time-shared computer work in administration may in one firm be known and be considered a part of the firm by the drafting supervisors, and in another company the same type of equipment would not be known or considered part of the company's facilities.

The types of automated equipment reported by the fourteen companies are shown with the number of companies reporting each type. Also included in this display are the data regarding the use by draftsmen and the equipment expected to be added within the year.

Numbers of Firms Reporting Automated Drafting Equipment
Number of firms visited = 34

	Presently In Use	Used By The Draftsmen	Expected Within The Year
Plotter	7	3	5
Digitizer	5	1	2
Computer	4	1	1
Diagrammer	3	2	2
Electrostatic Copier	3	1	-
Time Shared Computer	1	-	1
Cathode Ray Tube and Light Pen System	1	-	2

The automated drafting equipment was reportedly used by draftsmen in eight out of twenty-four cases. Those supervisors that reported the use of equipment by others than draftsmen, described the operators' classifications in many different terms and with indications of varying levels. Computers were reportedly operated by engineers, programmers and computer operators. Plotters were operated by computer graphics operators and plotter technicians, and engineers. Digitizers were operated by machine operators, some of whom were reported to be one or two pay grades below the draftsmen. Electrostatic copiers were operated by blueprinters if not by the draftsmen. Diagrammers were operated by draftsmen with special training. Light pen systems were operated by computer graphics operators.

The training reported for the automated devices consisted of on-the-job training in the operation of the particular devices, conducted by the vendor or by company employees who had been trained by the vendor.

There were no cases reported in which the automated equipment had reduced the number of draftsmen needed. Two companies reported that the automated drafting equipment had increased the need for draftsmen by ten percent at both firms, even though they both reported that the draftsmen did not use the equipment.

The information on retraining of draftsmen was sparse and varied, as eight supervisors at the fourteen companies said that some retraining for the use of automated equipment was necessary, and six said that no retraining was needed. The numbers of draftsmen involved in the training reported varied from 4 to 50 men per plant, and the time for retraining varied from 8 to 20 hours per man.

Expected Additions of Automated Drafting Devices

To investigate the likely changes in the near future, the supervisors were asked, "What automated drafting equipment do you expect to put in within the next year?" In response to this question five of the companies that had some automated equipment at the time expected to add some more within the year. Of the companies that reported having none at the time of the survey, six expected to add some within the next year. The items of equipment expected and the numbers of companies expecting each were: plotters 5, digitizers, diagrammers, and light pens, each 2, computers and time-shared terminals, each by one company.

In response to the question of training programs for draftsmen to use the new equipment, the supervisors indicated that very little training would be needed and that any training that was needed would be provided on the job and by the vendor or other members of the firm. If draftsmen do not operate the new automated devices, what additional training would they need to coordinate their responsibilities with the capabilities of the automated equipment? Responses to this question by the supervisors revealed that they anticipated that very little additional training would be needed by the draftsmen. Those that suggested any training indicated that only briefings or general knowledge of the functions of the equipment would be needed.

In summary, the replies about automated drafting equipment would indicate that:

1. Only twenty-five percent of it was used by the draftsman.
2. The implementation of the equipment has not reduced the need for draftsmen.
3. Whatever training is needed by the draftsman to operate it or coordinate his functions with those of the machines will be conducted on the job, by the vendor or by his employer.

The Ratings of Drafting Duties

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The compilations of findings from the interview survey forms completed by the draftsmen and instructors are displayed in Tables IX through XXII. These figures represent the computer print-out of the mean ratings of each task by each of the sub-groups of draftsmen and instructors. The importance of this information will vary with each reader. As a general approach to the study it was decided to classify the findings according to the meaningfulness the results would have for those interested in an overall appreciation of the needs of draftsmen. For this reason the responses that were found to have a mean rating of 3.0 or higher were underlined. This would mean that three out of four draftsmen classified this particular skill as very important with a rating of 4.0 or that the draftsmen in any one group gave that item an average rating of 3.0 indicating that it took a major portion of their time or was a major part of their work.

The fact that these responses are considered most meaningful in a general way does not mean that responses of lower ratings are less meaningful. For example, it would be expected that an architectural draftsman would percieve the need to read blueprints of floor plans as a major part of his job and rate this question with a response of 4.0 on the survey form. However, it might be more meaningful to learn that architecutral design draftsmen expressed a need for reading of blueprints of plumbing, heating and air conditioning plans with a rating as high as 2.0 particularly to those who might have thought of architectural design draftsmen as having responsibility only for artistic or aesthetic design. Therefore, the ratings of each item by each group have been presented in the original computer print-out of mean ratings in order to make it possible to compare ratings between groups or between items as the interests of the reader might direct him.

The Ratings as Perceptions of the Interviewees

A study of these tables will show that for the most part whenever an item or group of related items was rated highly by the participants in a particular field of drafting, the same items were rated highly by the instructors in that field. Further study will show that the ratings by the instructors are closer to the ratings by the supervisors, than they are to the ratings by draftsmen. This would tend to indicate that the needs of draftsmen in industry were perceived by the instructors more as they were by supervisors than as they were by draftsmen, indicating that the instructors' perceptions of needs of the draftsmen compares more closely with the perception of the supervisors than they do with those of the draftsmen.

Perhaps this fact indicates a very important consideration in this type of survey. Various drafting managers at times during the survey proposed the idea that it might not be the best plan to interview the draftsmen themselves but to concentrate on the supervisors and managers. The wisdom in this criticism lies not in the concept that the draftsmen do not know what their job needs are or what skills they use or functions they perform. Rather the problem is one of verbal communications and classifications of duties. As one drafting manager expressed this problem in the interview, too many draftsmen are unable to express themselves in matters of drafting. They don't know the words that describe their operations.

This lack of verbal skills may be the reason for the low responses to some of the areas that draftsmen would be expected to respond to with high ratings. They just didn't recognize the job operation by the term presented. It was for this reason that questions were asked using terms that would be those most likely used on the job. Terms such as "brown lines" in place of "reproducible intermediates" and "Xerox" in place of "electrostatic copies" and "Mylar" in place of "polyester films" were used as they represent the popular terms of the trade. It might be that the suggestion of a drafting manager that, "teachers should teach draftsmen how to express themselves verbally about drafting" would be one of the most important suggestions for curriculum revision to come out of this study.

Despite the limitations of the draftsmen just presented it would seem that their responses would be meaningful to a study of their needs on the job. It must be remembered that no two draftsmen have identical backgrounds or job requirements, and many of the specialized skills and functions are not readily classifiable into general descriptions. Thus it would be well for persons reviewing the tabulations of the ratings to consider them as relative within a question area and within a respondent field and level and not try to relate them to any absolute scale of total job requirements.

In order to use the results of this study most effectively for the purpose for which it was introduced, the responses to each question will be reviewed in search of implications for automated drafting and for specialized drafting i major fields.

Suggestions for Curriculum Revisions from the Plus and Minus Checks

The plus and minus columns on the survey permitted the participants to identify things that they felt should have been given more emphasis or less emphasis in the drafting courses they had taken. The responses on these columns for each question by each group were tabulated. As the participants were asked not to try to check every item but "only those items that stand out in your needs," it was felt that if half the participants in any one group checked an item as plus or minus that response would be meaningful to the purpose of this study. None of the items were marked with a minus by 50% of any group. In order to identify the questions marked with a plus by more than half the participants in any one group and also identify the group so marking the question, plus signs were placed on the tables as superscript symbols over the corresponding rating figures in the table; thus in Table IX question 1-6 (the reading of electrical schematics) was marked plus by 50% of the supervisors of electronic designers, as is indicated by the super-script plus, for that group.

TABLE IX

MEAN RATINGS OF THE NEEDS FOR BLUEPRINT READING IN SELECTED FIELDS
BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

1 READING BLUEPRINTS OF -	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen.Instr.
1-01 MECHANICAL DETAILS	0.9	1.4	1.5	3.0	1.2	0.7	0.8	1.0	1.0	1.0	1.8	2.3	2.5	2.4	3.3	2.6	2.9	3.1	3.2	3.4	1.4	1.4	1.0	2.0	1.5	3.0
1-02 MECHANICAL ASSEMBLIES	0.8	1.3	0.6	1.0	1.2	0.4	0.7	0.3	0.8	1.8	1.8	2.3	2.3	2.1	2.8	2.5	2.9	2.9	3.3	3.3	0.9	1.4	0.7	1.6	1.3	3.0
1-03 TOOL DRAWINGS	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.3	0.3	0.0	0.7	0.8	0.5	0.8	1.2	0.6	1.4	0.6	1.9	2.2	0.1	0.2	0.0	0.2	0.0	1.5
1-04 INSTALLATION DRAWINGS	0.9	1.3	1.1	1.0	1.1	0.4	0.7	0.0	1.0	0.3	1.2	1.7	1.4	1.8	1.7	1.4	1.9	1.7	2.2	2.1	1.4	1.5	0.3	2.4	1.8	1.5
1-05 WIRING DIAGRAMS	0.3	1.2	0.5	1.0	2.1	0.4	0.2	0.0	0.8	0.8	2.2	2.4	2.8	2.5	3.2	1.0	1.3	1.4	1.2	1.4	0.1	0.5	0.3	0.6	1.5	1.5
1-06 ELECTRICAL SCHEMATICS	0.3	1.2	0.3	1.0	1.0	0.2	0.0	0.0	0.5	0.0	2.2	2.2	3.1	3.3+	2.3	0.9	0.9	1.3	1.3	1.3	0.3	0.3	0.0	0.2	0.8	1.5
1-07 ELECTRONIC SCHEMATICS	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.3	0.3	0.0	2.5	2.9	2.6	3.1	4.0	0.9	0.9	1.3	1.1	1.4	0.0	0.1	0.0	0.0	0.3	1.5
1-08 PRINTED CIRCUIT BOARDS	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.0	2.4	2.7	2.5	3.4+	3.3	0.8	0.7	1.4	1.0	1.4	0.1	0.1	0.0	0.0	0.3	1.0
1-09 WELDED MODULES	0.6	0.0	0.0	0.0	0.8	0.1	0.5	0.0	0.0	0.3	0.8	1.7	1.5	1.5	2.0	0.6	0.8	1.0	1.0	1.2	0.1	0.7	0.0	0.6	0.3	1.8
1-10 LOGIC DIAGRAMS	0.1	0.1	0.0	0.0	0.1	0.1	0.3	0.3	0.3	0.0	1.3	2.5	2.3	2.3+	2.3	0.3	0.4	0.8	0.8	1.0	0.1	0.3	0.0	0.4	0.5	1.0
1-11 BLDG. PLANS, SINGLE STORY	2.9	3.3	3.0	4.0+	3.9	1.1	0.7	2.0	2.0	1.5	0.1	0.1	0.0	0.3	1.2	0.0	0.2	0.2	0.0	0.2	1.5	2.2	3.7	2.8	3.3	1.3
1-12 BLDG. PLANS, MULTI-STORY	2.9	3.2	3.1	4.0+	3.2	1.0	0.3	1.7	1.0	1.5	0.1	0.0	0.3	0.0	0.8	0.0	0.2	0.1	0.0	0.2	1.9	1.9	3.7	2.8	3.3	0.3
1-13 ARCHITECTURAL DETAILS	3.5	3.6+	3.6+	4.0+	3.9	1.1	0.5	1.7	1.3	1.5	0.1	0.1	0.3	0.0	1.0	0.1	0.2	0.2	0.0	0.2	1.4	2.0	2.7	2.6	3.0	1.3
1-14 STRUCTURAL STEEL DETAILS	2.0	2.3	1.5	3.0+	3.0	1.3	1.2	1.3	1.5	1.0	0.1	0.3	0.3	0.3	0.7	0.3	0.8	0.8	0.6	1.2	3.1	3.7	3.7	3.0+	3.5	1.0
1-15 STRUCTURAL STEEL DIAGRAMS	1.4	1.6	1.0	2.0	2.6	1.1	1.0	1.0	1.5	1.0	0.1	0.2	0.0	0.3	0.3	0.1	0.5	0.3	0.1	1.1	2.8	3.4	3.7	3.0	3.3	1.0
1-16 MAPS OR SITE PLANS	1.8	2.4	2.3	3.0	3.8	3.5	3.2	3.7	3.8+	4.0	0.2	0.1	0.3	0.1	0.5	0.1	0.1	0.4	0.2	0.9	1.1	1.3	2.0	2.6	3.0	1.3
1-17 PIPING DIAGRAMS	0.6	1.0	0.9	1.0	1.3	1.3	0.5	1.0+	2.0	1.3	0.3	0.3	0.1	0.1	0.8	0.7	0.9	1.0	0.6	1.6	1.9	1.3	1.7	1.8	1.3	2.0
1-18 PIPING PARTS, ASSEMBLIES	0.1	0.7	0.3	1.0	1.2	0.8	0.7	0.3	1.3	0.5	0.2	0.3	0.1	0.1	0.2	0.8	0.9	1.2	0.7	1.6	1.5	1.0	1.0	1.4	0.8	1.8
1-19 FLOW CHARTS AND DIAGRAMS	0.3	1.0	0.4	0.0	0.8	0.9	1.3	1.0	1.5	0.5	1.0	1.3	1.3	0.6	1.5	1.1	1.1	1.4	1.7	1.1	0.5	0.7	0.0	1.0	0.8	1.3
1-20 PNEUMATIC, HYDRAULIC DWGS.	0.0	0.4	0.0	0.0	0.1	0.1	0.2	0.7	0.8	0.3	0.2	0.5	0.5	0.5	0.3	0.6	1.1	1.1	1.1	1.1	0.4	0.3	0.0	0.4	0.3	0.8
1-21 PLUMB., HEAT., A/C PLANS	1.4	2.0	1.1	3.0	3.8	0.3	0.2	0.7	0.5	0.5	0.0	0.1	0.3	0.4	0.3	0.3	0.5	0.4	0.4	0.6	0.7	1.1	1.3	1.4	2.3	0.5
1-22 SHEET METAL DRAWINGS	0.9	1.2	1.6	2.0	1.0	0.0	0.3	0.3	0.3	0.3	1.0	1.9	1.4	1.5	2.0	1.8	2.3	2.4	2.6	2.1	1.2	1.0	1.3	1.2	2.0	2.0
1-23 WELDED FABRICATION DWGS.	1.3	0.7	1.0	0.0	0.7	0.2	0.7	0.0	1.0	0.8	0.7	1.7	1.1	1.5	1.7	1.8	2.2	2.1	2.9	2.4	2.3	2.7	2.0	2.8	1.8	1.3
1-24 /OTHER/	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	1.0	1.0	0.1	0.3	0.0	1.3	0.3	0.1	0.4	0.0	0.4	0.3	0.0	0.9	0.0	2.0	0.0	0.0
1-25 /OTHER/	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.1	0.0	0.0	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.4	0.0	2.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

The Ratings by Draftsmen, Supervisors and Instructors

The meaningfulness of the ratings will be appreciated best if the instructions to the draftsmen and instructors are kept in mind. The draftsmen were instructed to rate those things that were more or less important to their jobs as follows: from 0 for "things you do not do" to 4 for the "things which take all, or almost all, your time, or things at which you are normally a full-time specialist." (See Appendix B-8.) The instructors were asked to rate the same items and to indicate the importance of them in their particular drafting course or program from 0 for "things that are not a part of your program," to 4 for "things that all students who complete the program must know or be able to do." (See Appendix C-3.)

It would seem, then, that if these two scales were kept in mind as the tables are studied, those items that received a mean rating of 0.0 - 1.0 would be the least important on the job and would be only lightly introduced by the drafting instructor; those items receiving a mean rating of 1.0 - 2.0 would be of minor importance on the job and would be given less than average emphasis by the instructor. Those items receiving mean ratings between 2.0 - 3.0 would be of major importance on the job and would be given more than average emphasis by the instructor. Those items receiving mean ratings between 3.0 and 4.0 would be of highest importance on the job and would receive the most emphasis in the drafting programs.

Blueprint Reading. It would be expected that the various draftsmen would give a higher rating to the reading of blueprints in their own fields than they would to any other blueprints. Those types of blueprints readily identifiable with a particular field would be used more by draftsmen in that field than any other types. In reviewing Table IX, it might be of more interest to note the types of blueprints that are needed to a lesser degree but to some degree by draftsmen in all five fields. Such types of blueprints as "piping diagrams," "flow charts and diagrams," "sheet metal drawings" and "welded fabrication," would seem to have some importance to draftsmen in every field and their ratings might suggest to instructors that they try to incorporate at least an introduction to these types of drawings in whatever program they teach.

Design Drafting. In the areas of architectural and civil engineering, the design or layout work is performed by architects and engineers. Some non-degree draftsmen are assigned to do the design and lay-out work but to a lesser extent than draftsmen are in other fields. As shown in Table X, design drafting is more restricted to a specialized field and design draftsmen are not expected to perform design duties in other fields.

Each person studying this table will find different data meaningful according to his own interest. For example, it might be of interest to one person to note that electronics design draftsmen appear to be doing design work on mechanical details and assemblies

TABLE X

MEAN RATINGS OF THE NEEDS FOR DESIGN DRAFTING SKILLS IN SELECTED FIELDS
BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

-2 DOING DESIGN DRAFTING OF –	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					Gen.Instr.
	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	
2-01 MECHANICAL DETAILS	0.0	0.9	0.3	0.0	0.4	0.1	0.3	0.3	0.8	1.0	1.2	2.2	1.0	2.3	2.7	2.2	3.1	2.0	3.3	3.5	0.5	0.9	0.3	1.3	1.3	4.0
2-02 MECHANICAL ASSEMBLIES	0.0	0.8	0.0	0.0	0.4	0.1	0.2	0.0	0.0	1.0	1.3	2.2	0.6	2.3	2.7	2.1	3.1	2.0	3.4	3.4	0.5	0.7	0.0	1.3	1.3	4.0
2-03 TOOL DRAWINGS	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.5	0.4	0.6	0.3	0.8	0.5	0.6	1.0	0.4	1.8	2.5	0.0	0.0	0.0	0.8	0.0	1.5
2-04 INSTALLATION DRAWINGS	0.3	0.8	0.9	0.0	0.6	0.0	0.3	0.0	0.8	0.3	0.8	1.5	0.3	1.5	2.0	1.0	1.8	1.1	2.1	2.1	0.5	0.9	0.0	1.8	2.3	2.5
2-05 WIRING DIAGRAMS	0.0	0.3	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	1.6	2.1	1.6	2.6	3.7	0.8	0.7	0.9	1.2	1.4	0.0	0.1	0.0	0.0	1.5	1.5
2-06 ELECTRICAL SCHEMATICS	0.0	0.6	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.5	1.5	2.1	1.6	2.8+	2.5	0.7	0.5	1.1	1.1	1.5	0.0	0.0	0.0	0.0	1.3	2.0
2-07 ELECTRONIC SCHEMATICS	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	1.8	2.6	1.6	2.5	3.8	0.5	0.5	1.2	0.9	1.3	0.0	0.0	0.0	0.0	0.0	2.0
2-08 PRINTED CIRCUIT BOARDS	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	1.9	3.0	2.1+	2.4+	3.8	0.6	0.5	1.1	0.7	1.2	0.0	0.1	0.0	0.0	0.5	2.0
2-09 WELDED MODULES	0.3	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.5	0.4	1.7	1.1	1.0	1.8	0.5	0.7	0.8	0.9	1.4	0.0	0.9	0.0	0.3	0.0	2.3
2-10 LOGIC DIAGRAMS	0.0	0.2	0.0	0.0	0.1	0.1	0.5	0.0	0.0	0.0	1.0	2.2	1.1	2.0	2.0	0.1	0.4	0.8	0.6	0.9	0.0	0.1	0.0	0.3	0.0	1.3
2-11 BLDG. PLANS, SINGLE STORY	1.6	3.6	3.1	4.0	3.6	0.4	0.8	1.3	1.8	0.8	0.0	0.0	0.0	0.0	1.0	0.0	0.1	0.0	0.0	0.2	0.5	1.9	2.0	2.8	3.3	0.8
2-12 BLDG. PLANS, MULTI-STORY	1.5	3.3	3.5	4.0	3.0	0.4	0.5	1.3	0.8	0.8	0.0	0.0	0.0	0.0	0.7	0.0	0.1	0.0	0.0	0.2	0.5	1.8	1.3	2.8	3.3	0.3
2-13 ARCHITECTURAL DETAILS	2.6	3.4	3.5+	4.0	3.7	0.3	0.7	1.0	0.3	0.8	0.0	0.0	0.1	0.0	0.3	0.0	0.2	0.0	0.0	0.1	0.7	1.5	1.7	1.0	3.0	0.8
2-14 STRUCTURAL STEEL DETAILS	0.6	1.3	0.8	1.0	3.2	0.6	1.3	0.3	1.5	1.0	0.2	0.2	0.1	0.0	0.2	0.1	0.6	0.6	0.4	1.0	2.0	3.5	2.7	3.0	3.3	1.0
2-15 STRUCTURAL STEEL DIAGRAMS	0.4	0.9	0.4	0.0	2.7	0.6	1.3	0.7	1.3	1.0	0.1	0.1	0.0	0.0	0.2	0.0	0.2	0.2	0.1	0.9	1.2	3.3	2.7	2.8	3.3	0.8
2-16 MAPS OR SITE PLANS	1.0	2.2	2.0	1.0	3.7	2.3	2.7	2.7	3.8+	2.8	0.0	0.0	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.7	0.1	0.7	1.3	1.8	3.3	0.8
2-17 PIPING DIAGRAMS	0.0	0.3	0.0	0.0	1.3	0.2	0.7	0.7	2.0	0.5	0.0	0.2	0.1	0.1	0.2	0.3	0.8	0.9	0.2	1.5	0.0	0.2	0.3	1.0	1.3	1.0
2-18 PIPING PARTS, ASSEMBLIES	0.0	0.3	0.1	0.0	1.2	0.3	0.3	0.0	1.5	0.5	0.1	0.2	0.1	0.3	0.2	0.5	0.9	1.1	0.4	1.5	0.0	0.2	0.0	0.8	1.3	0.8
2-19 FLOW CHARTS AND DIAGRAMS	0.3	1.3	0.0	0.0	0.6	0.5	1.0	0.7	1.8	0.5	0.6	1.0	0.4	1.0	1.5	0.7	0.7	1.1	1.0	0.9	0.0	0.2	0.0	0.5	0.8	0.8
2-20 PNEUMATIC, HYDRAULIC DWGS.	0.0	0.2	0.0	0.0	0.1	0.3	0.2	0.3	1.0	0.3	0.1	0.3	0.3	0.4	0.0	0.5	0.7	0.8	1.0	1.2	0.0	0.3	0.0	0.3	0.5	1.0
2-21 PLUMB., HEAT., A/C PLANS	0.1	0.4	0.6	0.0	2.4	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.1	0.5	0.3	0.0	0.5	0.0	0.3	0.3	0.3	1.3	1.0
2-22 SHEET METAL DRAWINGS	0.0	0.7	1.3	2.0	0.8	0.0	0.0	0.0	0.3	0.3	0.6	1.8	0.8	1.6	1.7	1.4	2.0	2.0	2.8	2.4	0.2	0.9	1.0	0.8	0.3	2.0
2-23 WELDED FABRICATION DWGS.	0.0	0.0	0.0	0.0	0.3	0.1	0.7	0.0	1.0	0.3	0.5	1.4	0.5	1.5	1.5	1.3	2.1	1.7	2.7	2.6	1.3	2.1	1.0	3.3	1.0	1.3
2-24 /OTHER/	0.0	0.4	0.0	0.0	0.0	0.2	0.0	0.0	1.0	0.0	0.0	0.2	0.0	0.9	0.3	0.2	0.4	0.0	0.4	0.0	0.0	0.3	0.0	1.8	0.0	0.0
2-25 /OTHER/	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	1.8	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

as they are on wiring diagrams and electrical schematics. Another person reviewing the data might note that design drafting in welding fabrication is uniformly not considerd a part of the architect's job but falls under the responsibilities of the mechanical and structural designers.

Detail Drafting. A review of the data on detail drafting in Table XI will show considerable flexibility in the skills needed by electronics and mechanical detailers in order to work in both fields. Similarly, for the architectural and structural draftsmen there appears to be considerable overlapping of responsibilities. These data would support the suggestions made elsewhere in the interviews that draftsmen should be flexible enough to work in two related fields but probably not more than two.

A study of this table will also show the amount of detail work done by the designers. This data would indicate that levels of responsibility are not as well defined as some would try to classify them. In many situations designers are required to do their own detail drafting and be able to complete a finished working drawing as well as to "rough out" the designs for others to complete. This would mean, then, that the designers, at present, are still in need of good drafting techniques and should not be encouraged to skip lightly over the development of these skills during their training.

Lettering. Freehand lettering was shown in Table XII to be the most widely used form by all levels of draftsmen in all the fields studied, generally well above the 3.0 level. Typing was shown to be the least important of the four methods presented with only five of the groups rating it as high as the 1.0 level. No methods other than those presented were rated any higher than the 0.5 level. Mechanical lettering devices and transfer lettering were used about equally by all classifications, generally between the 1.0 and 2.0 levels. Transfer lettering as found to have a slight preference by architectural draftsmen and the mechanical devices were preferred slightly in the other fields.

Sources of Information. Drafting instructors as well as those from many other areas of vocational-technical education are often criticized for requiring the students to work too much from the textbook and for not bringing in practical problems from industry. In an attempt to learn what uses draftsmen made of various sources of information and what emphasis instructors placed upon these sources in their course work as well as to determine if the sources had any implications for automation, question 5 was designed to determine the needs for some common types of reference materials.

Table XIII shows that information obtained through "sketches by others" and from "oral instructions" were both rated very highly by draftsmen and supervisors in all fields and by the instructors

TABLE XI

MEAN RATINGS OF THE NEEDS FOR DETAIL DRAFTING SKILLS IN SELECTED FIELDS
BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
3 DOING DETAIL DRAFTING OF –	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen. Instr.
3-01 MECHANICAL DETAILS	0.3	0.6	0.5	0.0	0.3	0.2	0.3	0.0	0.5	0.0	1.8	1.8	2.1	2.3	2.8	2.9	2.3	3.3	2.5	3.9	0.5	0.9	1.0	1.3	1.0	4.0
3-02 MECHANICAL ASSEMBLIES	0.1	0.4	0.4	0.0	0.3	0.1	0.0	0.0	0.0	0.0	1.9	1.8	2.1	2.0	2.7	2.7	2.2	3.1	2.9	3.7	0.5	0.8	0.7	1.5	1.3	4.0
3-03 TOOL DRAWINGS	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.1	0.8	0.7	0.8	0.8	0.8	1.8	2.2	0.0	0.1	0.0	0.3	0.0	1.5
3-04 INSTALLATION DRAWINGS	0.5	0.4	1.0	1.0	0.3	0.2	0.3	0.0	0.8	0.0	1.1	1.3	1.0	1.3	2.0	1.4	1.5	1.6	1.8	1.7	0.8	0.9	0.0	1.5	1.3	2.0
3-05 WIRING DIAGRAMS	0.1	0.1	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	2.2	1.8	2.4	2.6	3.5	1.0	0.7	1.2	1.0	1.5	0.0	0.1	0.0	0.0	0.8	1.8
3-06 ELECTRICAL SCHEMATICS	0.1	0.4	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	2.0	1.8	3.0	2.6	2.3	0.9	0.5	1.3	1.0	1.5	0.0	0.1	0.0	0.0	0.8	2.0
3-07 ELECTRONIC SCHEMATICS	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	2.1	2.1	2.5	2.3	3.5	1.0	0.6	1.3	0.8	1.4	0.0	0.0	0.0	0.0	0.0	2.0
3-08 PRINTED CIRCUIT BOARDS	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	2.4	2.3	2.8	2.4	3.3	0.8	0.5	1.4	0.6	1.3	0.0	0.1	0.0	0.0	0.0	2.0
3-09 WELDED MODULES	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.8	1.3	1.6	1.4	2.0	0.8	0.6	0.9	0.8	1.5	0.3	0.6	0.0	0.3	0.3	1.8
3-10 LOGIC DIAGRAMS	0.1	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.5	1.9	1.8	1.8	2.3	0.3	0.3	0.8	0.6	1.1	0.0	0.1	0.0	0.3	0.3	1.5
3-11 BLDG. PLANS, SINGLE STORY	3.5	3.2	3.1	4.0	3.9	0.8	0.2	1.0	1.5	0.5	0.0	0.1	0.3	0.0	0.3	0.1	0.0	0.0	0.0	0.2	1.5	1.9	3.7	2.3	3.5	1.0
3-12 BLDG. PLANS, MULTI-STORY	2.6	3.3	3.1	4.0	3.9	0.7	0.0	1.0	0.8	0.5	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.9	1.7	3.7	2.3	3.5	0.5
3-13 ARCHITECTURAL DETAILS	3.9	3.6	3.4	4.0	3.9	0.7	0.2	0.7	0.5	0.5	0.1	0.0	0.1	0.0	0.3	0.0	0.1	0.1	0.0	0.2	0.5	1.2	2.3	1.5	3.3	0.8
3-14 STRUCTURAL STEEL DETAILS	1.4	1.4	0.9	1.0	2.9	1.1	0.8	0.7	1.5	0.5	0.2	0.2	0.1	0.0	0.5	0.1	0.4	0.8	0.6	1.1	3.1	3.3	3.7	3.0	3.3	1.9
3-15 STRUCTURAL STEEL DIAGRAMS	0.8	0.9	0.4	0.0	2.3	0.8	0.8	0.7	1.3	0.5	0.0	0.1	0.0	0.0	0.3	0.0	0.2	0.3	0.1	1.1	2.6	3.3	3.7	2.8	3.0	0.7
3-16 MAPS OR SITE PLANS	1.8	2.3	1.8	1.0	3.9	3.4	2.3	3.7	2.8	2.5	0.2	0.0	0.3	0.0	0.2	0.1	0.1	0.1	0.1	0.8	0.2	0.8	2.0	1.0	3.3	1.0
3-17 PIPING DIAGRAMS	0.3	0.4	0.0	0.0	1.6	0.7	0.3	0.7	1.3	1.3	0.2	0.1	0.1	0.1	0.3	0.4	0.6	1.0	0.3	1.5	1.2	0.4	1.0	0.8	0.8	1.0
3-18 PIPING PARTS, ASSEMBLIES	0.0	0.1	0.0	0.0	1.3	0.4	0.2	0.0	0.8	0.5	0.1	0.2	0.1	0.3	0.2	0.6	0.6	1.2	0.7	1.6	1.1	0.5	0.0	0.8	0.8	0.7
3-19 FLOW CHARTS AND DIAGRAMS	0.6	1.3	0.0	0.0	0.7	0.8	0.7	1.0	1.0	0.5	0.6	0.8	0.8	0.6	1.5	0.7	0.6	1.2	0.7	1.0	0.0	0.4	0.0	0.5	0.3	0.3
3-20 PNEUMATIC, HYDRAULIC DWGS.	0.0	0.2	0.0	0.0	0.6	0.4	0.2	0.3	0.5	0.0	0.2	0.2	0.4	0.3	0.0	0.5	0.7	0.9	0.4	1.2	0.0	0.3	0.0	0.0	0.0	1.0
3-21 PLUMB., HEAT., A/C PLANS	0.1	0.3	0.6	0.0	1.9	0.1	0.0	0.0	0.0	0.5	0.0	0.0	0.1	0.1	0.3	0.2	0.4	0.4	0.0	0.5	0.0	0.3	0.3	0.3	0.5	1.3
3-22 SHEET METAL DRAWINGS	0.3	0.7	1.3	1.0	1.1	0.0	0.0	0.0	0.3	0.0	1.0	1.3	1.8	1.6	1.7	1.9	1.7	2.6	2.3	2.3	1.0	0.8	1.0	0.8	0.3	2.0
3-23 WELDED FABRICATION DWGS.	0.6	0.0	0.0	0.0	0.8	0.0	0.2	0.0	1.0	0.5	0.7	1.2	1.4	1.5	1.5	1.4	1.5	2.2	2.6	2.7	2.1	2.3	1.7	3.0	1.0	1.3
3-24 /OTHER/	0.0	0.0	0.0	0.0	0.4	0.3	0.7	0.0	1.0	0.0	0.0	0.1	0.0	0.4	0.3	0.1	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.8	0.0	0.0
3-25 /OTHER/	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.8	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

TABLE XII

MEAN RATINGS OF THE NEEDS FOR LETTERING SKILLS IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

04 LETTERING YOU DO –	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen.Instr.
4-01 FREEHAND	3.6	3.6	4.0	4.0	3.9	3.1	3.3^{+}	3.7	3.8^{+}	4.0	3.4	3.4	3.4	3.5	3.8	3.6	3.5	3.7	3.4	4.0	3.6	3.9	2.7	3.8	4.0	3.8
4-02 TYPEWRITER	0.3	0.7	0.1	0.0	0.4	0.1	0.3	1.3	0.5	0.5	0.4	0.5	0.6	1.3	0.0	0.4	0.5	1.1	1.0	0.6	0.7	0.2	0.7	0.0	1.0	1.0
4-03 LE ROY OR SIMILAR	0.8	1.3	1.0	0.0	2.4	2.4	1.8^{+}	3.3	2.3	3.3	1.2	1.1	1.4	1.1	2.0	1.3	0.8	1.0	1.3	2.4	0.3	0.8	1.7	1.4	3.0	2.3
4-04 PRES-TYPE OR SIMILAR	1.1	1.8	1.8	1.0	3.1	0.9	0.2	2.7	0.8	1.5	0.5	1.1	1.0	0.9	2.8	0.4	0.3	1.2	0.3	1.4	0.1	0.4	0.3	0.6	0.8	1.3
4-05 /OTHER/	0.1	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.1	0.1	0.0	0.5	0.0	0.1	0.1	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

TABLE XIII

MEAN RATINGS OF THE USES OF VARIOUS SOURCES OF INFORMATION IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

05 SOURCES OF INFORMATION	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen.Instr.
5-01 SKETCHES BY OTHERS	3.1	3.0	2.8	4.0	3.2	2.9	2.5	3.7	2.5	2.8	3.0	3.2	3.0	3.3	2.2	3.0	2.3	3.3	3.0	2.5	2.7	2.7	2.7	3.4	4.0	2.3
5-02 ORAL INSTRUCTIONS	3.3	3.1	2.8	4.0	3.9	2.9	2.8	2.7	3.0	3.0	2.9	3.2	2.8	3.3	3.0	2.8	2.9	2.7	2.8	3.8	2.6	2.7	3.0	3.4	4.0	2.5
5-03 VENDOR CATALOGS	2.1	3.2	2.5	4.0	3.8	1.3	1.3	0.3	1.3	1.8	2.4	2.8	2.1	2.4	3.2	2.4	2.5	2.6	2.7	3.1	2.1	1.7	2.0	2.4	3.8	3.5
5-04 MILITARY STANDARDS	0.4	0.7	1.0	1.0	0.7	0.6	0.8	0.7	1.0	2.3	2.0	2.6	2.8	2.4	3.2	2.0	1.9	1.7	2.4	2.9	0.7	1.4	0.7	1.2	1.0	3.5
5-05 CORP. SPECIFICATIONS	1.1	2.1	1.6	1.0	1.9	1.3	1.7	0.7	2.3	2.0	2.5	2.7	2.6	2.3	2.8	2.5	2.4	3.3	3.3	2.5	2.2	1.9	1.3	2.4	1.5	3.0
5-06 TRADE STANDARDS	2.4	3.0	2.8	2.0	3.8	1.8	1.8	1.0	2.0	2.3	1.4	2.0	1.6	1.5	3.3	1.5	2.1	2.2	2.0	3.1	2.3	2.5	1.0	2.6	3.5	3.0
5-07 COUNTY, NATL. CODES	2.3	3.1	2.6^{+}	4.0	3.9	3.4	2.7	2.0	2.5	3.0	0.3	0.5	0.5	0.5	2.0	0.4	0.8	0.8	0.3	1.1	1.5	2.3	2.0	3.2	3.5	1.8
5-08 /OTHERS/	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.1	0.1	0.0	0.4	0.5	1.2	0.3	0.0	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

as well. During the interviews some instructors expressed the opinion that well planned presentations at the chalkboard and discussions of drawings in progress at the student's work station could be close simulations of practical job situations wherein the draftsmen are briefed on a project in a group with follow-up instructions on specific details provided singly or in small groups at the drawing board. If classroom instruction could be designed to provide information in a way similar to briefings in industry, not just lectures with note taking, the students would be getting valuable experience in working from oral instructions.

Military standards were expected to be important to draftsmen in electronics and mechanical drafting as many of the companies were envolved with military production. It has been generally assumed that many companies not required to use military standards for their drawings would be using them as the basis for an industry-wide standard. This assumption was not substanciated to any considerable degree by the data in Table XIII. Military standards were rated only slightly above average by electronics draftsmen, (2.0 - 2.8) about average by mechanical draftsmen, (1.7 - 2.4) and lower by draftsmen in other fields.

A general overview of the ratings would indicate that instructors are aware of the sources of information used by the draftsmen and place proper emphasis on them in their courses. The ratings of the various sources of information did not indicate any influence on the draftsman's training relative to automated devices.

Tools and Equipment Used by the Draftsmen An important indicator of the effects of automation on the work of the draftsmen would be the use he makes of automated equipment. The data in Table XIV would substantiate other expressions throughout the interviews that the draftsmen have little need for skills related to the computer at this time.

The civil designers expressed the most need for computer aided design as they rated "prepare work for the computer," at the 2.2 level, and the feeding of cards and typing into the computer at the 1.0 and 1.2 levels respectively.

Drafting machines appear to be replacing T-squares and parallel rules in all areas except architectural and civil drafting where the traditional equipment is still in use. Slide rules and calculators were both rated about average in use by all participants with both slide rules and calculators being given a higher rating by the civil draftsmen: generally 2.5 and 3.0 respectively.

The ratings on the types of scales used would indicate specialization more than flexibility as the scales used may be clearly identified with the draftsman's field. Architectural, civil and structural draftsmen as a group expressed a need for architects'

TABLE XIV

MEAN RATINGS OF THE USE OF TOOLS, EQUIPMENT AND MEASUREMENTS IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
06 TOOLS, EQUIPMENT YOU USE -	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen.Instr.
6-01 DWG. BOARD, T-SQUARE	1.0	1.4	1.4	4.0	1.4	1.8	1.2	0.3	2.8	2.8	0.7	0.8	0.3	0.0	1.0	1.5	0.7	0.0	1.2	1.1	1.9	1.1	2.0	1.2	2.3	2.8
6-02 PARALLEL RULE	2.9	3.4	3.0	4.0	2.2	2.0	2.5	2.0	1.5	2.0	0.6	0.9	0.6	0.4	0.8	0.8	0.4	0.7	0.2	0.5	1.0	1.4	2.3	0.2	2.0	0.0
6-03 DRAFTING MACHINE	1.4	0.8	2.0	0.0	2.3	1.4	0.5	1.7	2.3	4.0	3.5	3.6	3.5	3.6	3.5	3.6	3.6	3.8	3.9	3.6	2.5	3.3	2.3	2.6	4.0	3.5
6-04 SLIDE RULE	1.0	1.8	1.6	1.0	2.2	1.1	2.5	2.3	3.0	2.8	0.8	1.7	1.0	1.1	1.8	1.0	2.1	1.6	2.1	2.5	1.0	3.0	2.0	1.8	3.5	3.3
6-05 CALCULATOR	1.5	0.8	1.0	2.0	1.3	2.5	3.0	3.0	3.0	4.0	0.6	1.4	1.3	1.0	1.0	0.8	1.4	1.2	1.8	1.5	1.7	2.1	1.7	2.0	2.8	1.0
COMPUTER, WORK YOU DO																										
6-06 /1/ PREPARE WORK	0.0	0.0	0.4	0.0	0.3	0.9	2.2	1.7	2.0	1.5	0.6	0.3	1.4	0.9	0.0	0.4	0.4	1.3	0.9	0.5	0.5	0.5	1.0	1.0	0.8	1.0
6-07 /2/ PUNCH THE CARDS	0.0	0.0	0.0	0.0	0.3	0.1	0.7	0.3	0.3	1.5	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.0	0.0	0.5	1.0
6-08 /3/ FEED THE CARDS	0.0	0.0	0.0	0.0	0.4	0.1	1.0	0.3	0.5	1.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	1.0
6-09 /4/ TYPE INTO COMPUTER	0.0	0.0	0.0	0.0	0.4	0.3	1.2	0.3	0.8	1.3	0.1	0.1	0.0	0.8	0.0	0.1	0.1	0.0	0.7	0.0	0.0	0.0	0.3	0.0	0.3	1.0
6-10 ARCHITECTS SCALE	3.1	3.2	3.4	4.0	4.0	1.9	2.7	2.0	2.0	3.3	0.7	0.5	0.9	0.9	2.3	1.1	0.9	0.8	0.9	2.4	3.3	3.7	3.7	3.6	4.0	2.0
6-11 MACHINISTS SCALE	0.3	0.0	0.5	0.0	1.1	0.0	0.0	0.3	0.0	1.5	2.2	2.3	3.3	2.4	4.0	2.2	2.4	2.9	3.2	3.1	0.2	0.3	0.0	0.4	1.8	2.5
6-12 CIVIL ENGINEERS SCALE	2.5	3.1	2.6	3.0	2.3	3.8	3.8	4.0	4.0	4.0	0.6	0.2	0.9	0.3	1.8	0.7	0.7	0.8	0.4	1.8	1.8	2.5	2.7	3.2	4.0	2.3
6-13 TEMPLATES	3.0	2.7	2.1	4.0	3.6	2.8	2.7	3.3	2.0	3.5	2.6	3.1	3.8	2.9	4.0	3.1	2.8	2.9	3.0	3.6	1.8	2.7	3.7	3.2	4.0	2.5
6-14 PLANIMETER	0.6	0.9	0.5	0.0	1.3	1.7	1.8	1.7	1.5	3.3	0.3	0.1	0.4	0.1	0.5	0.1	0.2	0.0	0.2	0.9	0.5	0.9	0.7	2.0	2.0	1.3
07 MEASUREMENTS YOU USE -																										
7-01 FRACTIONAL DIMENSIONS	3.1	3.6	3.1	4.0	4.0	1.8	2.8	2.7	3.0	3.0	1.8	2.0	1.1	1.3	2.5	2.1	2.2	1.8	1.4	3.0	3.4	3.9	3.7	3.6	3.5	2.8
7-02 DECIMAL DIMENSIONS	2.6	2.7	1.5	4.0	2.4	3.3	3.5	4.0	4.0	4.0	3.3	3.4	3.4	3.6	4.0	3.4	3.5	3.8	3.6	3.9	2.5	2.9	2.0	2.0	4.0	3.5
7-03 INCH-FOOT MEASUREMENTS	3.8	3.7	3.5	4.0	4.0	2.4	3.2	3.0	3.0	3.3	1.6	1.3	1.1	1.8	2.0	1.4	1.7	2.2	1.9	1.8	3.9	3.7	3.7	3.6	4.0	2.8
7-04 METRIC MEASUREMENTS	0.9	0.6	0.0	1.0	0.6	0.3	0.7	0.0	0.5	1.8	0.6	0.5	0.8	0.5	1.8	0.5	0.6	1.0	0.4	0.9	0.5	0.8	1.7	1.0	1.3	0.5
7-05 COORD. DIMENSIONS FOR N/C	0.3	0.7	1.1	0.0	0.3	0.8	0.0	1.3	0.5	0.5	0.8	1.3	2.4	2.1	2.5	1.3	1.1	2.3	1.6	1.9	0.3	0.5	0.7	0.2	1.0	1.8
7-06 TRUE POS. TOLERANCING	0.0	0.1	0.6	0.0	0.7	0.1	0.5	0.0	0.3	0.5	1.6	2.2	1.3+	2.0	2.5	1.5	2.1	1.7	2.4	2.3	0.3	0.3	0.3	0.4	0.3	3.5
7-07 SURFACE QUALITY SYMBOLS	0.1	0.1	0.1	0.0	0.8	0.1	0.5	0.0	0.5	0.5	1.5	1.7	1.5	1.3	2.0	1.8	2.4	2.7	2.9	2.9	0.9	0.9	0.3	0.8	0.3	3.5
7-08 FORM TOLERANCE SYMBOLS	0.0	0.1	0.0	0.0	0.8	0.1	0.2	0.0	0.0	0.5	1.2	1.5	1.3	1.5	2.2	1.5	2.0	2.2	2.4	2.5	0.5	0.2	0.3	0.2	0.3	3.5
7-09 /OTHER/	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

scales and civil engineers' scales. Electronics and mechanical draftsmen expressed a need for machinists' scales.

Measurements Used in Drafting. A review of the types of measurements needed by draftsmen in the five fields of this study as presented in Table XIV, shows that fractional dimensions were used more in the architectural and structural fields, and decimal dimensions were used more in the civil, electronics and mechanical fields. However, both systems were reported to be needed by all draftsmen with sufficient emphasis to assure instructors that general understanding beyond familiarity would be needed in each system. Metric measurements were given low ratings by all groups indicating that the need for this system was not great at the time of the study.

Coordinate dimensioning and true position tolerancing have been considered to be some preparatory steps toward computer aided drafting. Digitizing of drawings depends heavily upon a working knowledge and use of these systems. The low ratings placed on these two items would indicate that the draftsmen in this study did not feel a need for this type of preparation for automated drafting.

Surface quality symbols and form tolerance symbols have been strongly associated with military standards and the low rating accorded their need in this study would substantiate the low rating of the military standards shown on Table XIII.

Materials Currently Used by Draftsmen. Drafting instructors are often criticized for not teaching the use of materials that are up to date with the needs of industry. As shown in Table XV, opaque paper is used by designers in architectural and civil drafting with ratings from 2.0 to 3.0, but its use was rated between 0.5 and 1.5 by other groups. Opaque paper was reportedly being used in drafting departments of various fields where microfilms are made from the opaque drawing and used for further distribution and filing.

The development of special skills for drafting on both vellum and Mylar were rated highly by all the draftsmen in this study with architectural and mechanical draftsmen rating vellum higher than Mylar. Instructors' ratings compared very favorably with those of the draftsmen indicating an awareness of the materials and emphasis in instruction comparable to the needs of industry.

The use of linen is still of some importance in civil and structural drawing as was expressed under "others" by draftsmen in these areas. Drafting with lead whether in pencils or mechanical holders was rated highest of any media by all fields of draftsmen. As shown in Table XV, some use of plastic pencil was needed by draftsmen in all fields, although not to a very high degree. The use of ink was rated higher by civil draftsmen than by any other field but they all expressed some need for its use. The electronics draftsmen rated tapes and pads higher than any other group of draftsmen did,

TABLE XV

MEAN RATINGS OF THE USE OF VARIOUS DRAFTING MATERIALS IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
08 MATERIALS YOU DRAW ON –	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen. Instr.
8-01 OPAQUE PAPER	1.3	2.2	2.0	4.0	2.6	1.0	0.8	3.0	2.3	3.0	0.4	0.9	0.1	0.8	1.3	0.7	0.7	0.6	1.0	1.0	1.5	1.5	1.0	0.6	2.3	1.5
8-02 VELLUM	3.6	3.6	3.1	3.0	3.9	2.4	2.2	2.7	3.5	4.0	3.1	3.0	2.8	3.1	4.0	3.4	3.3	3.3	3.4	4.0	2.3	2.9	3.0	3.6	4.0	3.8
8-03 MYLAR OR SIMILAR	2.0	2.4	1.8	3.0	1.7	3.0	3.3	4.0	3.3	4.0	2.8	3.0	3.6	2.3	3.0	2.3	1.9	2.7	1.7	2.1	1.5	2.1	3.0	3.2	2.5	1.8
8-04 /OTHER/	0.0	0.3	0.0	0.0	0.0	1.3	0.5	0.0	1.0	2.0	0.0	0.0	0.5	0.4	0.0	0.2	0.1	0.4	0.8	0.3	1.1	0.8	0.0	1.4	0.0	0.0
09 MATERIALS YOU DRAW WITH –																										
9-01 LEAD PENCIL OR LEAD HOLDER	3.8	3.7	3.5	4.0	4.0	3.3	3.7	3.7	3.5	4.0	3.1	3.5	3.3	3.4	3.8	3.4	3.7	3.6	3.9	3.9	3.9	3.8	3.7	3.8	4.0	4.0
9-02 PLASTIC PENCIL	1.4	1.6	1.5	0.0	0.3	2.2	2.7	0.7	1.5	2.3	1.7	1.6	2.3	1.5	1.2	1.3	1.0	1.8	0.9	1.7	0.7	1.7	1.3	1.2	1.8	1.0
9-03 INK	1.0	2.0	1.0	0.0	3.1	3.1	2.2	4.0	2.8	4.0	1.8	1.5	1.5	1.1	2.2	1.4	0.8	1.0	0.8	2.3	0.2	0.6	1.0	1.2	2.3	2.3
9-04 TAPES AND PADS	1.3	1.2	1.1	1.0	1.4	1.4	1.0	3.0	1.3	1.5	2.0	2.2	2.5	2.4*	3.3	1.3	0.8	1.6	1.3	1.4	0.5	0.9	1.0	0.2	1.5	2.0
9-05 SCRIBER	0.5	0.6	0.5	0.0	0.3	1.6	0.2	2.3	0.3	2.8	0.5	0.4	0.3	0.4	0.5	0.5	0.2	0.0	0.1	0.8	0.2	0.2	0.3	0.0	0.5	1.3
9-06 /OTHER/	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

but all groups expressed some need for these newer forms of drafting materials.

Mathematics Used by Draftsmen. The needs for mathematics by draftsmen is shown in Table XVI. As rated by the participants of this study, the use of algebraic formulas was needed less than the use of trigonometric formulas which was rated above average by every group except the architectural draftsmen.

The architectural draftsmen rated only the use of handbooks of mathematics tables as above average and along with the draftsmen in other fields expressed a very low rating for logarithms, calculus, nomograms and analytic geometry.

The use of algebraic and trigonometric formulas and handbooks of tables were the needs that were rated highest by the draftsmen indicating perhaps that a technical mathematics course based on practical applications of these items would satisfy the needs of most draftsmen.

Geometric Constructions. It will be noted in Table XVI that the only participants rating any geometric constructions above 3.0 were the instructors. The construction of tangent arcs and irregular curves were rated above average by the civil and structural draftsmen. Although the draftsmen in other fields rated these skills lower, they did, however, all express some need for them. Constructions of conic sections were rated with very little need by the architectural and civil draftsmen and slightly higher, but less than average, by all the others.

The Types of Drawings Draftsmen Make. The question of the types of drawings that draftsmen in various fields make was asked in order to learn of any suggestions for automated drafting and specialization in the work of the draftsmen. As shown in Table XVII draftsmen in all fields rated one-view drawings higher than average. Only the instructors expressed a rating higher than 2.0 for any of the types of pictorial drawings. When studied separately the architectural, mechanical and structural draftsmen were found to express some need (between 1.0 and 2.0) for isometric and perspective sketches but very little need, (generally less than 1.0) for scaled isometric or scaled perspective drawings.

The generally high ratings of multi-view projections by participants in all areas and levels would indicate the need for basic projections by all draftsmen. It would illustrate, for example, that the electronics draftsmen are not simply specialists in schematics, wiring diagrams, printed circuit layouts and other one-view drawings. As many expressed during the interviews, they can not specialize to that extent, but must be able to make drawings of assemblies and installations and, in many instances, make any types of mechanical drawing

TABLE XVI

MEAN RATINGS OF THE USE OF MATHEMATICS AND GEOMETRIC CONSTRUCTIONS IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
10 MATHEMATICS YOU USE -	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen.Instr.
10-01 ALGEBRAIC FORMULAS	1.1	1.6	1.4	1.0	1.8	1.8	2.0	1.7	3.0	3.5	1.0	2.0	0.6	1.5	3.3	1.5	2.1	2.2	2.8	3.3	2.9	2.6	1.7	2.0	3.8	3.3
10-02 TRIGONOMETRIC FORMULAS	1.5	1.7	1.9	1.0	2.4	3.1	3.2	2.3	3.3	4.0	0.7	2.2	1.5	2.0	2.5	1.6	2.6	2.6	3.0	3.0	2.7	3.0	2.0	3.2	3.8	3.3
10-03 TRIGONOMETRIC IDENTITIES	0.6	1.2	0.8	1.0	1.1	1.7	1.8	1.0	2.5	2.8	0.2	1.1	0.8	1.1	0.8	0.8	1.8	1.7	1.9	1.1	1.7	2.0	0.7	1.8	1.3	1.0
10-04 LOGARITHMS, BASE 10	0.6	0.1	0.3	0.0	0.4	0.7	1.3	0.7	2.3	2.0	0.2	0.9	0.5	0.6	0.5	0.5	1.1	1.6	1.4	1.8	2.2	2.1	2.0	1.6	2.5	1.7
10-05 LOGARITHMS, OTHER BASES	0.3	0.0	0.3	0.0	0.0	0.2	0.8	0.3	0.5	1.0	0.1	0.5	0.3	0.4	0.2	0.1	0.3	0.2	0.4	0.8	0.1	1.0	0.3	1.0	2.0	1.5
10-06 CALCULUS	0.0	0.0	0.3	0.0	0.4	0.2	0.7	0.0	0.5	0.5	0.0	0.6	0.3	0.3	0.0	0.1	0.3	0.2	0.6	0.4	0.7	0.7	0.3	0.2	0.5	0.5
10-07 NOMOGRAMS	0.0	0.0	0.1	0.0	0.8	0.3	1.0	0.0	1.5	1.5	0.0	0.4	0.3	0.4	0.7	0.1	0.4	0.3	0.9	1.2	0.1	0.4	0.7	1.6	1.8	1.5
10-08 ANALYTIC GEOMETRY	0.6	0.4	0.5	1.0	0.3	0.6	1.0	1.0	1.8	1.0	0.5	1.0	0.5	1.3	0.7	0.6	1.0	0.9	0.7	0.9	0.7	1.3	0.7	0.8	0.8	1.0
10-09 DESCRIPTIVE GEOMETRY	1.6	1.1	1.3	2.0	2.3	1.3	0.8	1.0	2.0	2.3	1.0	1.3	0.8	1.8	2.0	1.3	1.8	1.7	1.9	3.2	2.0	2.1	2.0	2.4	1.3	3.3
10-10 HANDBOOKS OF MATH. TABLES	1.1	2.2	2.1	3.0	2.4	2.4	2.5	1.0	2.5	3.0	1.0	2.3	1.9	2.0	2.5	1.8	2.6	2.7	2.8	2.8	2.9	3.1	2.3	3.6	2.3	2.3
10-11 /OTHER/	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.8	0.0	0.0
11 GEOM. CONSTRUCTIONS -																										
11-01 CONSTRUCTIONS OF POLYGONS	0.4	1.6	1.0	1.0	1.8	1.3	1.7	1.7	1.0	2.8	0.4	0.8	0.8	1.3	2.0	0.7	1.2	1.7	1.3	2.9	2.1	1.8	1.0	2.4	3.0	3.3
11-02 CONST. OF TANGENT ARCS	0.6	1.1	1.6	1.0	1.8	2.6	2.2	2.0	2.3	3.3	0.4	1.2	0.6	1.4	2.5	1.4	1.8	1.9	1.9	3.6	2.1	2.1	2.0	2.4	3.0	3.3
11-03 CONST. OF CONIC SECTIONS	0.0	0.6	0.9	0.0	0.9	0.7	0.7	0.3	0.3	2.0	0.4	0.6	0.6	1.1	1.2	0.5	1.1	1.3	0.9	2.6	1.9	1.3	1.0	1.6	2.0	2.3
11-04 CONST. OF IRREG. CURVES	0.5	1.2	1.3	1.0	1.8	2.3	2.0	2.3	1.8	3.3	0.8	1.1	0.8	1.4	1.2	1.1	1.4	1.1	1.9	3.0	2.1	1.8	1.7	1.6	2.3	3.0
11-05 /OTHERS/	0.1	0.3	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.5	0.1	0.0	0.0	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

TABLE XVII

MEAN RATINGS OF THE TYPES OF DRAWINGS MADE BY DRAFTSMEN IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
12 TYPES OF DWGS. YOU MAKE -	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen. Instr.
12-01 ONE VIEW DRAWINGS	1.5	2.2	2.3	3.0	1.1	2.3	2.9	3.7	1.3	2.8	2.8	2.3	3.4	3.1	3.0	1.5	1.4	2.0	2.4	2.1	1.9	0.9	2.3	1.8	1.8	2.8
12-02 ISOMETRIC SKETCHES	1.3	1.1	1.1	2.0	3.0	0.5	0.5	0.7	0.5	2.5	0.9	1.2	1.6	1.3	2.8	1.4	1.4	1.4	1.8	3.4	0.5	1.5	1.7	1.4	2.8	2.8
12-03 SCALED ISOMETRIC DRAWINGS	0.9	1.0	1.1	2.0	2.1	0.6	0.3	0.7	0.5	2.5	0.8	0.8	1.6	0.6	2.2	0.9	0.7	1.2	0.4	3.3	0.5	1.0	1.3	0.6	2.0	1.5
12-04 PERSPECTIVE SKETCHES	1.1	1.9	1.5	1.0	3.9	0.3	0.0	0.7	0.8	1.5	0.7	0.8	0.6	0.9	1.2	0.8	1.1	0.8	1.1	1.4	0.1	1.2	1.3	0.8	2.3	1.8
12-05 SCALED PERSPECTIVE DWGS.	0.3	1.2	0.9	0.0	3.9	0.3	0.0	1.3	1.3	1.0	0.7	0.5	0.4	0.1	1.0	0.6	0.6	0.4	0.6	1.6	0.2	0.9	0.3	0.6	2.5	1.0
MULTI-VIEW PROJECTIONS																										
12-06 /1/ LAYOUT PROJECTIONS	0.9	1.4	0.8	2.0	1.8	0.8	2.7	0.7	0.8	1.5	1.0	2.1	2.5	1.8	3.8	2.4	2.8	2.8	2.2	3.9	2.1	2.3	3.0	2.8	3.0	3.5
12-07 /2/ SECT. VIEWS OF PARTS	1.1	2.3	1.3	3.0	2.2	1.0	2.5	0.3	0.5	2.3	1.8	2.2	2.3	2.0	2.8	2.8	2.9	3.0	3.1	4.0	3.3	2.7	3.0	3.2	4.0	2.8
12-08 /3/ SECT. VIEWS OF ASSYS.	1.0	1.4	1.3	3.0	2.2	0.8	1.7	0.3	0.3	1.5	1.9	2.3	2.1	2.4	2.7	2.7	2.8	3.0	2.2	4.0	2.7	2.7	3.0	3.0	3.8	2.8
12-09 /4/ SINGLE AUXILIARY VIEWS	0.8	1.4	1.3	1.0	1.2	0.7	1.7	1.3	0.3	1.5	1.5	1.9	1.9	2.1	1.8	2.1	2.5	2.1	2.8	3.9	2.3	1.9	3.0	3.2	3.5	3.5
12-10 /5/ AUX. VIEWS OF AUX.	0.5	0.7	0.9	1.0	0.8	0.5	1.0	1.0	0.3	1.5	0.6	1.0	1.6	0.9	1.8	1.0	1.8	1.1	2.1	3.3	1.5	1.5	1.3	1.2	3.0	3.5
12-11 /6/ REMOVED, ROTATED VIEWS	0.5	0.8	0.4	1.0	0.8	0.4	0.8	0.0	0.3	1.3	1.5	1.3	1.8	1.8	2.2	1.6	2.1	1.3	2.8	3.6	1.5	1.5	2.0	1.6	2.5	3.5
INTERSECTIONS + DEVELOPMENTS																										
12-12 /1/ PRISMS AND PYRAMIDS	0.0	0.8	0.3	0.0	0.4	0.2	0.2	0.0	0.3	0.8	0.2	0.2	0.6	0.3	0.7	0.3	0.6	0.7	0.8	2.6	0.9	0.6	0.3	1.2	1.0	1.8
12-13 /2/ CYLINDERS AND CONES	0.1	1.0	0.3	0.0	0.4	0.2	0.3	0.0	0.3	0.8	0.4	0.6	0.9	0.9	1.0	0.9	1.1	1.3	1.0	2.6	1.8	1.5	0.3	1.4	1.0	2.5
12-14 /3/ TRIANGULATION	0.1	0.4	0.3	0.0	0.4	0.3	0.7	0.7	0.5	0.8	0.2	0.3	0.3	0.6	0.5	0.4	0.7	0.3	0.9	1.8	1.0	0.9	0.0	1.0	1.0	2.0
GEARS AND CAMS																										
12-15 /1/ MAKE DETAIL DRAWINGS	1.3	1.8	1.6	0.0	1.6	1.5	1.3	1.0	1.8	1.0	1.4	1.5	1.5	1.4	1.8	1.6	1.4	2.6	1.3	3.5	1.5	1.6	1.3	0.8	0.3	3.0
12-16 /2/ LAYOUT ASSEMBLY DWGS.	0.4	0.2	1.5	0.0	0.7	0.6	0.5	0.3	1.0	1.0	1.4	1.8	1.1	1.9	1.3	1.7	1.7	2.3	1.7	3.4	1.1	1.3	0.7	1.0	0.3	3.0
12-17 /3/ CALCULATE SIZES	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.4	0.0	0.5	1.0	0.5	0.8	0.3	0.9	2.6	0.1	0.3	0.0	0.2	0.3	2.7
SCREW THREADS AND FASTENERS																										
12-18 /1/ SYMBOLS OF THREADS	0.1	0.4	0.4	0.0	0.4	0.3	0.7	0.3	0.0	1.0	1.2	1.5	1.9	0.9	2.5	2.1	1.7	2.1	2.7	3.8	1.1	0.8	2.0	1.6	1.5	3.5
12-19 /2/ DETAILS OF THREADS	0.1	0.3	0.3	0.0	0.4	0.3	0.0	0.3	0.0	0.5	0.8	0.7	0.8	0.4	1.2	0.9	0.8	1.1	1.1	3.2	0.7	0.4	0.7	0.8	0.5	1.5

TABLE XVII (continued)

12 TYPES OF DWGS. YOU MAKE –	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen. Instr.
FOR N/C MACHINES OR ASSEMBLY																										
12-20 /1/ DWGS. WITH SPEC. DIM.	0.0	0.4	0.9	0.0	0.6	0.6	0.0	0.7	0.0	0.5	1.0	1.1	2.1	2.0	0.5	0.8	0.9	1.0	1.2	1.7	0.5	0.5	0.3	0.4	0.8	0.0
12-21 /2/ PROGRAMS FOR N/C	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	1.0	0.0	0.3	0.1	0.0	0.8	1.1	0.0	0.1	0.3	0.0	0.3	0.0
PREPARE DWGS. FOR INPUT TO																										
12-22 /1/ COMPUTER	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.7	0.0	0.0	0.6	0.5	0.6	0.6	0.0	0.3	0.3	0.9	0.1	0.5	0.2	0.4	1.0	0.0	0.3	0.7
12-23 /2/ DIGITIZER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	1.6	0.6	0.2	0.1	0.1	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.3	0.0
12-24 /3/ DIAGRAMMER	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.3	0.2	0.1	0.0	0.0	0.1	0.3	0.0	0.1	0.0	0.0	0.3	0.0
12-25 /4/ /OTHER/	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

required of the general mechanical draftsmen.

The drafting of intersections and developments would appear, from Table XVII, to be too highly specialized for the needs of any of any of the draftsmen in this study. Some need was expressed for work with cylinders and cones by architectural, mechanical, and structural draftsmen but the ratings were not over the 2.0 level by any group except the instructors.

It might be surprising to many to note the uniformity of need for making detail drawings of gears and cams. The need for this area of drafting was rated between 1.0 and 2.0 by almost every group of participants. The layout of assembly drawings of gears and cams was rated between 1.0 and 2.0 by the mechanical and electronics draftsmen but not as high by those in the other fields. The need for calculating the sizes for cams and gears was rated very low (less than 1.0) by all draftsmen probably indicating that this work is the responsibility of the engineers.

Screw threads and fasteners are found on drawings of assembled parts and structures in all areas of drafting. The need for drawing the symbols of threads was rated above average by only the mechanical draftsmen, and the rating of the need for detailing of threads was scarcely above 2.0 by the mechanical draftsmen and below 1.0 by all the others.

Questions 20 and 21 under part 12 asked specifically about drawings for numerical control. The preparation of drawings with special dimensions for numerical control was rated 2.1 and 2.0 by the supervisors of electronics detailers and electronics designers respectively. The other participants in electronics drafing and the mechanical draftsmen gave ratings of approximately 1.0 to their needs for this type of drafting. All the other draftsmen rated it less than 1.0 indicating that the draftsmen has very little need for skills related to numerical control machining or assembly. The ratings shown on Table XVII for the need to write programs was even lower. Only the supervisors of electronics design draftsmen rated it as high as 1.0; all others rated it lower.

In an attempt to determine the skills needed for automated drafting the participants were asked to rate the preparation of drawings for input to the computer, digitizer, and diagrammer. Only the supervisors of structural detailers rated the need for the preparation of drawings for the computer as high as 1.0; all other groups rated it much lower. The preparation of drawings for the digitizer was rated 1.6 by the supervisors of electronics detailers; but 0.6 was the highest rating given to this type of work by any other group. A rating of 0.4 was the highest given by any group for the preparation of drawings for the diagrammer; 14 groups rated it zero.

The ratings of the types of drawings the draftsmen are making produced no more evidence of need for specialized drafting for automation than the responses in other parts of the check list or the answers to questions asked in other parts of the interview.

The Use of Printout Information. As draftsmen work within the team structure of research, engineering, documentation and production, automated devices used in related areas will exert some influence upon their activities. Information presented to the draftsmen representing design data, calculations, test results and other necessary parameters may be in the form of printout sheets from the computer or other automated drafting devices. The use of the printout materials whether in alpha-numeric or graphic mode might require some special training in the interpretation of the data as they are received by the draftsmen.

Question 13 was designed to determine the draftsmen's use of information produced by automated devices. If the use of this information requires special training, there may be some implications for curriculum revisions in the drafting programs in the junior colleges.

The data presented in Table XVIII shows that the use of printout information from the computer was rated 3.0 and 2.3 by the supervisors of civil detailers and designers respectively, and 2.2 by supervisors of structural designers. Supervisors of electronics and mechanical draftsmen rated this item from 1.1 to 1.9. Only the architectural group rated it uniformly as low as 0.1, indicating very little need for the use of computer printouts at this time. No other source of automated information, either listed or written in by the participants, was rated above 0.9 on this question.

The Use of Computer Languages. Recent developments in the use of computer systems have produced special languages for calculations in various fields of engineering. The use of these languages by draftsmen would be one indication of the extent of their involvement in automated drafting.

As shown in Table XVIII, the need for Fortran was rated 1.8 by supervisors of design draftsmen in civil engineering and 1.3 by supervisors of detail drafting in structural engineering. Instructors in civil drafting rated the need for this language at the 2.8 level. All other groups of draftsmen and instructors rated the need for Fortran below the 1.0 level. The write-in responses to this question suggested only various forms of basic programming were needed. Supervisors of civil detail draftsmen rated these forms of language at the 1.3 level.

Of the 130 possible responses from all groups to all parts of this question 87 responses were 0.0, indicating that there was little or no need at the time for any language by any of the groups in the study. Only instructors and supervisors rated the need for any

TABLE XVIII

MEAN RATINGS OF THE USE OF COMPUTER PRINT-OUT INFORMATION AND COMPUTER LANGUAGES IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
13 USE PRINTOUT INFO. FROM -	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen.Instr.
13-01 COMPUTER	0.1	0.1	0.1	0.0	0.0	1.5	1.2	3.0	2.3	2.5	0.8	1.1	1.9	1.1	0.0	0.6	0.9	1.9	1.4	0.3	1.4	1.0	1.7	2.2	0.5	0.5
13-02 DIGITIZER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.5	0.9	0.6	0.0	0.1	0.2	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0
13-03 DIAGRAMMER	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.1	0.1	0.5	0.3	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
13-04 /OTHER/	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14 LANGUAGES YOU USE -																										
14-01 FORTRAN	0.0	0.0	0.3	0.0	0.0	0.3	0.5	0.0	1.8	2.8	0.1	0.2	0.4	0.6	0.0	0.2	0.2	0.1	0.4	0.4	0.2	0.2	1.3	0.2	0.5	0.5
14-02 ALGOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
14-03 COBOL	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.5	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.5
14-04 ADAPT	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0
14-05 /OTHER/	0.0	0.0	0.0	0.0	[illegible]	[illegible]	0.8	1.3	0.0	0.0	0.1	0.2	0.9	0.0	0.0	0.1	0.1	0.0	0.4	0.2	0.0	0.1	0.3	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

language above the 1.0 level, which might be indicative of prediction by them rather than expressions of current needs of the draftsmen in their fields.

Reproduction Equipment Used by Draftsmen. The ratings of the use of reproduction equipment by the draftsmen as shown in Table XIX would indicate a general need for blueprinting and electrostatic copying equipment to about the same degree. Approximately one-third of the participating groups rated both items higher than 2.0 level, and more than four-fifths of the groups rated them both higher than the 1.0 level. The use of microfilm cameras was rated 1.9 by the supervisors of electronics designers but less than 1.0 by all other groups.

Close examination of Table XIX showed that instructors rated the blueprint equipment higher than did their industrial counterparts, but they rated the Xerox copiers more nearly the same as did the participants from industry. It might be that the instructors placed more emphasis on the blueprinting equipment as an instructional tool for demonstrating the printability of lettering and linework on drawings, but did not regard the Xerox equipment in the same way. However, cost and availability of the equipment for use by the students might also be an important factor.

"Scissors" Drafting. The methods of making new drawings from prints of older but similar projects is known as "cut and paste" or "scissors" drafting. The draftsman cuts the usable parts from an existing drawing, modifies them, pastes them on a new drawing, adds new information and makes a new reproducible master. A variety of techniques may be employed using "bluelines," "brownlines," electrostatic copies, and many types of full-size and reduced-size photo prints.

While these techniques may not be considered "automated" in any electronic sense, the object of using them is to reduce labor costs and time required for production and distribution of drawings. If the use of reproduction equipment is expected of the draftsmen as part of his work in scissors drafting, for making check prints, reference copies or for any other purpose more emphasis in the training in the use of reproduction equipment might be desirable in drafting programs.

The use of the various techniques generally required for scissors drafting were rated about equally as shown in Table XIX. There were no ratings over 3.0 for needs of any of the techniques, and the only ratings above 2.0 were by supervisors and instructors.

These ratings of above average importance may be more predictive of future needs than indicative of present needs. Each of the techniques was rated 1.0 or above by more than half the participating groups. While this rating indicates below average importance to the draftsman's needs, it does suggest sufficient need for consideration of these techniques in any drafting curriculum. The fact that all

TABLE XIX

MEAN RATINGS OF THE USE OF DRAWING REPRODUCTION EQUIPMENT AND SCISSORS DRAFTING TECHNIQUES IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
15 REPRODUCTION EQUIPMENT -	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen. Instr.
15-01 BLUEPRINTER/WHITEPRINTER	0.9	0.8	2.1	3.0	3.9	0.2	0.7	2.3	0.3	2.8	1.9	1.7	2.8	1.9	2.8	2.4	1.2	1.2	1.1	3.6	2.3	1.3	1.7	1.8	4.0	3.5
15-02 XEROX COPIERS OR SIMILAR	1.4	1.8	2.4	3.0	1.9	1.6	0.7	3.3	2.5	2.8	1.5	2.0	2.1	1.8	1.7	1.8	1.8	1.9	1.7	1.9	2.5	1.9	2.0	1.6	2.8	1.7
15-03 MICROFILM CAMERAS	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.3	0.5	0.0	0.3	0.4	0.4	1.9	0.0	0.4	0.4	0.0	0.2	0.4	0.0	0.8	0.0	0.2	0.0	0.0
15-04 /OTHERS/	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
16 SCISSORS DRAFTING -																										
16-01 W/BLUEPRINTS/WHITEPRINTS	1.4	1.3	0.6	1.0	1.0	1.3	0.8	2.0	1.5	2.3	1.3	1.2	1.6	0.8	1.5	1.0	1.1	1.4	1.2	0.5	0.5	1.6	0.7	0.6	1.0	1.5
16-02 WITH BROWNLINES	1.5	1.2	1.3	2.0	0.9	1.3	0.5	2.0	1.8	2.3	0.6	1.1	0.5	0.8	2.2	0.8	0.9	0.8	0.7	1.0	0.5	1.0	0.7	1.2	1.3	1.5
16-03 WITH XEROX OR SIMILAR COPY	0.9	1.6	1.3	2.0	0.1	1.2	0.7	2.0	1.5	1.5	0.8	1.1	1.5	1.0	2.0	0.7	1.0	1.9	0.9	0.7	0.5	0.9	0.3	0.8	1.0	1.0
16-04 WITH PHOTO PRINTS	0.5	1.4	1.1	1.0	0.0	0.8	1.0	1.7	1.5	1.5	0.6	1.1	0.5	1.8	1.7	0.5	0.5	1.2	1.2	0.5	0.3	0.6	0.3	0.2	0.8	0.5
16-05 WITH ADHESIVE SYMBOLS,ETC.	1.0	1.8	1.8	2.0	1.1	0.7	0.5	1.0	1.5	2.3	0.8	1.4	2.9	1.8	2.7	0.8	0.4	1.7	1.2	1.0	0.5	0.6	1.0	1.0	1.0	1.5
16-06 /OTHERS/	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

groups rated their needs about equally would indicate that instruction in these techniques would not be part of a specialized option in drafting but more representative of the typical objectives of a cluster core for all draftsmen.

Related Information Needed by Draftsmen. The draftsmen as a technician needs to know more than "how" to draw. He needs to know what to show on a drawing and often how the worker who reads the drawing will interpret the information he is attempting to communicate. The draftsman needs to understand the problems of fabrication that will be encountered by those who read his drawings. Some of the related areas commonly associated with the fields of drafting were selected for the draftsmen to rate as necessary to their job. Their ratings of these related areas are shown in Table XX.

"Machine shop practices" were rated to be of major importance to the mechanical draftsmen, (2.2 - 2.9) of minor importance to the electronics draftsmen, (1.4 - 2.5) and of little importance to the others. "Building construction" was rated very high by architectural draftsmen (2.4 - 4.0), above average by the structural draftsmen (2.0 - 3.2), below average by the civil draftsmen, and of little importance by the others. "Surveying procedures" was rated as of major importance to civil draftsmen (2.0 - 3.0), of minor importance to architectural and structural draftsmen and very low by the others. "Electronics laboratory work" was rated as of minor importance to electronics draftsmen, of little importance to mechanical draftsmen, and of no importance to the architectural, civil and structural draftsmen. "Color and design" were rated as of little or no importance to the draftsmen in all the groups studied except the architectural draftsmen.

It might be interesting to note, at this point, that all levels of architectural drafting participants rated "color and design" below "building construction" and only slightly above "surveying procedures." This would agree with the data in Table XX and tend to identify the architectural draftsman's responsibilities as more related to the drawing of multiview of structural details than to the drawing of pictorial views and finished renderings.

The need for "data processing" was rated as very low by participants in all fields with strongest need, still only slightly above the 1.0 level, expressed by the civil draftsmen. These ratings would indicate little use of computer aided drafting on the part of the draftsmen at this time. Even though these firms were the ones most identified with automated drafting equipment, it would appear that any data processing needed for its use was not the responsibility of the draftsmen. "Strength of materials" was uniformly needed by all the fields studied. The designers and design supervisors all rated it above the 1.0 level and four out of the ten rated it above 2.0 level. From the expressions of need shown in Table XX, it would seem

TABLE XX

MEAN RATINGS OF THE NEED FOR RELATED INFORMATION AND THE RELATED DUTIES OF DRAFTSMEN IN SELECTED FIELDS BY DRAFTSMEN, SUPERVISORS AND INSTRUCTORS*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
17 RELATED INFORMATION -	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen. Instr.
17-01 MACHINE SHOP PRACTICES	0.5	0.4	1.0	1.0	0.0	0.4	0.2	0.0	0.0	0.5	1.7	2.5	1.4	2.1	2.8	2.2	2.9	2.3	2.9	3.3	1.5	0.9	0.3	1.2	0.8	3.0
17-02 BUILDING CONSTRUCTION	2.4	3.3	3.4	4.0	3.3	1.4	0.8	1.0	2.0	2.3	0.0	0.1	0.9	0.1	0.7	0.1	0.3	0.1	0.1	0.3	2.3	3.0	2.0	3.2	3.5	0.8
17-03 SURVEYING PROCEDURES	0.9	2.2	1.5	1.0	2.2	2.7	2.0	3.0	2.8	3.8	0.1	0.0	0.0	0.0	0.3	0.2	0.3	0.0	0.4	0.8	1.5	1.5	0.3	2.2	2.8	1.8
17-04 ELECTRONICS LAB WORK	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	2.0	1.3	1.6	2.3	0.4	0.9	1.1	1.3	1.1	0.0	0.0	0.0	0.0	0.3	1.3
17-05 COLOR AND DESIGN	1.5	2.2	2.1	3.0	2.2	0.7	0.3	1.0	0.0	0.8	0.6	0.7	1.1	0.6	0.2	0.3	0.7	0.2	0.6	0.5	0.0	0.6	0.0	0.4	1.0	1.3
17-06 DATA PROCESSING	0.0	0.6	0.4	0.0	0.0	0.6	1.0	1.0	1.3	2.3	0.2	0.6	1.4	0.6	0.2	0.2	0.3	0.7	1.1	0.5	0.5	0.5	0.0	0.2	0.8	0.5
17-07 STRENGTH OF MATERIALS	0.8	1.6	1.5	2.0	2.8	0.4	1.2	0.7	1.0	2.0	0.4	1.4	1.0	1.4	1.7	0.7	2.2	1.1	2.4	2.2	1.7	2.9	1.0	1.6	3.5	2.7
18 RELATED DUTIES -																										
18-01 CHECK DRAWINGS OF OTHERS	1.6	1.9	3.1	4.0	2.2	1.8	2.2	2.3	2.5	2.8	1.2	2.2	1.5	2.6	1.8	1.1	2.1	2.2	2.3	2.2	3.0	3.1	2.3	3.2	3.3	3.7
18-02 WRITE SPECIFICATIONS	1.1	0.6	1.1	1.0	2.2	0.4	1.0	0.7	2.0	1.0	0.5	0.9	0.4	1.3	1.7	0.4	0.8	0.3	1.4	1.5	0.7	1.3	0.7	1.6	2.3	2.0
18-03 MAKE DRAWING CHANGES	2.9	3.1	2.3	4.0	3.2	2.7	2.8	1.7	2.8	3.0	2.0	1.9	2.9	1.9	2.5	2.4	1.8	3.6	2.8	2.5	2.8	2.7	2.0	3.0	2.0	2.5

*For numbers of participants in each group, see p. 11. For explanation of rating scale 0.0 to 4.0, see Appendix B-8 and C-3.

that all draftsmen would benefit from a course in strength of materials and that it should be included in a core cluster of subjects for a drafting technology program.

Related Duties of Draftsmen. In addition to the basic job duties of making drawings, the draftsmen is often confrontd with other responsibilities necessary to the function of the department. Some examples of these related duties were tested in question 18. The need to "check the drawings of others" was rated above average in importance by all fields of draftsmen, as shown in Table XX. It was rated the highest level, above 3.0 by those in architectural and structural fields. The design draftsmen and supervisors in all fields rated it above the 2.0 level. The need for specification writing was not rated as high (generally between 1.0 and 2.0) but some need for it was shown by all fields of draftsmen. Designers and supervisors of design draftsmen expressed a slightly higher need than did detailers indicating that this is a function of more experienced draftsmen.

The need for making changes on drawings was shown to be high for all the fields studied. This need was rated close to or above the 2.0 level by all the participants. The importance of making drawing changes and working with the accompanying engineering orders and change notices should be understood by all drafting trainees so that they will be prepared for this phase of the work as well as for the making of new drawings.

Opinions on Training for Automated Drafting Devices

In response to question 19, both draftsmen and instructors expressed strong feelings that draftsmen should be trained to work with automated drafting devices. Regarding specific items there was less agreement. More need was expressed for taining in computers than in digitizers or plotters, although the majority of the participants failed to express their opinion on either digitizers or plotters. No other devices were named for proposed training by any meaningful number.

A summary of some of the data in Table XXI shows the amount of uncertainty regarding automated drafting devices as indicated by the large numbers of those participants who declined to express an opinion on this question.

Areas in which draftsmen need training.	Number of the 25 groups expressing a 50% or greater response.		
	Yes	No	No Answer
Computer aided design	22	3	0
Computers	16	0	9
Digitizers	2	0	23
Plotters	10	0	15

TABLE XXI

PERCENTAGES OF PARTICIPANTS EXPRESSING OPINIONS ON NEEDS FOR TRAINING IN USE OF AUTOMATED DRAFTING EQUIPMENT*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen, Instr.
19-01 DRAFTSMAN TRAINED FOR CAD																										
YES	62.5	55.6	37.5	0.0	44.4	87.5	100.0	33.3	75.0	75.0	76.0	85.0	87.5	87.5	66.7	62.2	71.2	88.9	66.7	76.5	81.8	66.7	66.7	60.0	50.0	50.0
NO	37.5	33.3	62.5	100.0	44.4	12.5	0.0	66.7	25.0	0.0	24.0	12.5	12.5	12.5	33.3	37.8	25.0	11.1	33.3	23.5	18.2	26.7	0.0	40.0	50.0	50.0
NA	0.0	11.1	0.0	0.0	11.1	0.0	0.0	0.0	0.0	25.0	0.0	2.5	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	6.7	33.3	0.0	0.0	0.0
19-02 /1/ COMPUTERS																										
YES	62.5	33.3	37.5	0.0	44.4	56.3	66.7	33.3	75.0	75.0	40.0	60.0	50.0	75.0	66.7	45.9	55.8	55.6	66.7	58.8	72.7	53.3	33.3	60.0	25.0	25.0
NO	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	4.0	2.5	12.5	0.0	0.0	8.1	0.0	11.1	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0
NA	37.5	66.7	62.5	100.0	55.6	37.5	33.3	66.7	25.0	25.0	56.0	37.5	37.5	25.0	33.3	45.9	44.2	33.3	33.3	35.3	27.3	46.7	66.7	40.0	75.0	75.0
19-03 /2/ DIGITIZERS																										
YES	12.5	0.0	12.5	0.0	11.1	12.5	0.0	0.0	0.0	25.0	12.0	30.0	62.5	50.0	16.7	5.4	11.5	44.4	22.2	5.9	9.1	0.0	0.0	20.0	0.0	0.0
NO	0.0	11.1	0.0	0.0	11.1	25.0	16.7	0.0	25.0	25.0	12.0	17.5	25.0	12.5	16.7	16.2	19.2	11.1	22.2	11.8	18.2	13.3	0.0	0.0	25.0	0.0
NA	87.5	88.9	87.5	100.0	77.8	62.5	83.3	100.0	75.0	50.0	76.0	52.5	12.5	37.5	66.7	78.4	69.2	44.4	55.6	82.4	72.7	86.7	100.0	80.0	75.0	100.0
19-04 /3/ PLOTTERS																										
YES	12.5	33.3	25.0	0.0	22.2	68.8	50.0	33.3	75.0	50.0	36.0	52.5	62.5	62.5	33.3	18.9	46.2	44.4	44.4	52.9	27.3	26.7	33.3	20.0	50.0	50.0
NO	12.5	11.1	12.5	0.0	0.0	6.3	16.7	0.0	0.0	25.0	8.0	12.5	25.0	12.5	0.0	8.1	7.7	11.1	0.0	0.0	9.1	6.7	0.0	0.0	0.0	0.0
NA	75.0	55.6	62.5	100.0	77.8	25.0	33.3	66.7	25.0	25.0	56.0	35.0	12.5	25.0	66.7	73.0	46.2	44.4	55.6	47.1	63.6	66.7	66.7	80.0	50.0	50.0
19-05 /4/ /OTHERS/																										
YES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	7.5	25.0	0.0	0.0	0.0	1.9	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NO	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	25.0	4.0	2.5	12.5	0.0	0.0	5.4	1.9	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0
NA	100.0	100.0	100.0	100.0	100.0	93.8	100.0	100.0	100.0	75.0	92.0	90.0	62.5	100.0	100.0	94.6	96.2	100.0	88.9	100.0	90.9	100.0	100.0	100.0	100.0	100.0
19-06 BEFORE FIRST JOB																										
YES	12.5	33.3	37.5	0.0	33.3	56.3	16.7	0.0	25.0	75.0	40.0	47.5	87.5	37.5	50.0	32.4	25.0	33.3	44.4	47.1	45.5	26.7	33.3	20.0	25.0	100.0
NO	37.5	22.2	0.0	0.0	11.1	31.3	83.3	33.3	50.0	25.0	28.0	37.5	0.0	50.0	16.7	32.4	44.2	55.6	22.2	29.4	36.4	40.0	33.3	40.0	25.0	0.0
NA	50.0	44.4	62.5	100.0	55.6	12.5	0.0	66.7	25.0	0.0	32.0	15.0	12.5	12.5	33.3	35.1	30.8	11.1	33.3	23.5	18.2	33.3	33.3	40.0	50.0	0.0
19-07 ON THE JOB																										
YES	62.5	33.3	12.5	0.0	11.1	50.0	83.3	33.3	50.0	100.0	60.0	67.5	62.5	87.5	50.0	56.8	57.7	77.8	55.6	64.7	63.6	53.3	66.7	40.0	25.0	50.0
NO	0.0	0.0	12.5	0.0	33.3	31.3	16.7	0.0	0.0	0.0	4.0	12.5	25.0	0.0	16.7	8.1	7.7	11.1	11.1	11.8	9.1	0.0	0.0	0.0	0.0	0.0
NA	37.5	66.7	75.0	100.0	55.6	18.8	0.0	66.7	50.0	0.0	36.0	20.0	12.5	12.5	33.3	35.1	34.6	11.1	33.3	23.5	27.3	46.7	33.3	60.0	75.0	50.0

*Percentages compiled for each group. For numbers of participants in each group, see p. 11.

As to the time of training, opinions were considered stronger for training on-the-job than for training before they seek their first job. These data substantiate the remarks made by the supervisors that the training for new automated devices would be conducted on the job by the vendors and previously trained company employees. The strong feelings favoring training on the job were also expressed vocally by interviewers as they pointed out that there are so many types of equipment that no one person would need to be trained in the operation of all, and the most efficient training would be conducted by the employer to suit the employee's needs. See Table XXI.

Opinions on Training for Specialization

With regard to drafting flexibility participants in all fields were stongly in favor of competency in more than one major field but not in more than two major fields. Flexibility was also emphasized in the responses to the draftsmens' opinions on training in depth or breadth as indicated by the fact that 22 groups responded affirmatively by more than 50% to emphasize breadth, while 16 groups responded affirmatively by more than 50% to emphasize depth. See Table XXII.

Suggestions for the Improvement of Drafting Training

On the last page of the check list the participants were provided the only question on the instrument enabling them to express themselves in their own words. In this question they were asked to offer suggestions for drafting programs on the high school or junior college levels. Having preceeded this question with two "yes" or "no" answer questions on automated drafting and specialization, it was hoped that the participants would take the suggestion and express themselves on these topics. Only two draftsmen and two instructors indicated a need for training in automated drafting, data processing or numerical control. Advocating more specialized training were 13 draftsmen, 8 supervisors, and 2 instructors. Advocating more flexibility in drafting training were 23 draftsmen and 3 supervisors. The topics of other suggestions were listed and the numbers of responses concerning each topic were recorded:

Topic	Draftsmen N = 219	Supervisors N = 58	Instructors N = 44
Related to academic preparation, usually mathematics	13	7	2
Drafting techniques, lettering line work, inking	22	6	2
Use of new drafting materials	5	2	1
Professional and business practices, documentation and systems	19	6	0
Work experience of field trips to see drafting rooms	17	5	1

Topic (continued)	Draftsmen N = 219	Supervisors N = 58	Instructors N = 44
Teachers with more vocational experience	3	1	4
AA programs transferable to BA programs	2	2	0
Occupational information, job possibilities	2	1	0
Shop or industrial language	4	3	0
Related to shop work, industrial practices	58	14	2

Four draftsmen suggested that students should be made to "think more" in classes. The instructors had some suggestions related to teaching that were not expressed in any way by draftsmen or supervisors:

Suggestions by Instructors	Number
More work with advisory committees	2
Better evaluation techniques	1
More drawing board work (at least 15 hours per week)	1
More up-to-date films	1

The results of this question would indicate that the participants were more concerned with basic drafting technology and related industrial practices as they would be needed on the job at present than they were in any projected use of automated devices that did not as yet pose any threats to their job security.

TABLE XXII

PERCENTAGES OF PARTICIPANTS EXPRESSING OPINIONS ON NEEDS FOR FLEXIBILITY IN DRAFTING TRAINING*

	ARCHITECTURAL					CIVIL					ELECTRONICS					MECHANICAL					STRUCTURAL					
	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Detail	Design	Sup. Det.	Sup. Des.	Instr.	Gen. Instr.
20 DRAFTING FLEXIBILITY –																										
20-01 COMP. IN MANY FIELDS																										
YES	37.5	66.7	75.0	100.0	88.9	56.3	100.0	33.3	100.0	100.0	92.0	90.0	100.0	75.0	83.3	94.6	88.5	66.7	88.9	70.6	90.9	80.0	33.3	100.0	100.0	100.0
NO	62.5	33.3	25.0	0.0	11.1	43.8	0.0	66.7	0.0	0.0	8.0	5.0	0.0	25.0	16.7	5.4	11.5	33.3	11.1	29.4	9.1	13.3	66.7	0.0	0.0	0.0
NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0
20-02 MORE THAN 2 MAJOR FIELDS																										
YES	25.0	33.3	12.5	100.0	44.4	12.5	50.0	33.3	50.0	0.0	28.0	37.5	37.5	37.5	33.3	32.4	32.7	22.2	55.6	47.1	45.5	40.0	33.3	40.0	50.0	25.0
NO	62.5	66.7	87.5	0.0	44.4	87.5	50.0	33.3	50.0	100.0	68.0	60.0	62.5	62.5	66.7	64.9	65.4	77.8	44.4	47.1	45.5	53.3	33.3	40.0	50.0	50.0
NA	12.5	0.0	0.0	0.0	11.1	0.0	0.0	33.3	0.0	0.0	4.0	2.5	0.0	0.0	0.0	2.7	1.9	0.0	0.0	5.9	9.1	6.7	33.3	20.0	0.0	25.0
20-03 TRAIN IN DEPTH																										
YES	50.0	88.9	62.5	100.0	22.2	68.8	66.7	33.3	75.0	75.0	36.0	50.0	62.5	75.0	66.7	51.4	30.8	44.4	33.3	52.9	27.3	53.3	66.7	100.0	50.0	25.0
NO	50.0	11.1	37.5	0.0	55.6	31.3	33.3	33.3	25.0	25.0	64.0	45.0	37.5	25.0	33.3	48.6	63.5	55.6	55.6	47.1	54.5	40.0	0.0	0.0	50.0	75.0
NA	0.0	0.0	0.0	0.0	22.2	0.0	0.0	33.3	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	5.8	0.0	11.1	0.0	18.2	6.7	33.3	0.0	0.0	0.0
20-04 TRAIN IN BREADTH																										
YES	62.5	33.3	75.0	100.0	77.8	43.8	50.0	66.7	25.0	50.0	88.0	65.0	62.5	62.5	83.3	78.4	75.0	55.6	77.8	64.7	63.6	60.0	100.0	60.0	75.0	100.0
NO	37.5	55.6	12.5	0.0	11.1	50.0	50.0	33.3	75.0	25.0	8.0	30.0	37.5	37.5	16.7	16.2	23.1	22.2	22.2	23.5	27.3	33.3	0.0	20.0	25.0	0.0
NA	0.0	11.1	12.5	0.0	11.1	6.3	0.0	0.0	0.0	25.0	4.0	5.0	0.0	0.0	0.0	5.4	1.9	22.2	0.0	11.8	9.1	6.7	0.0	20.0	0.0	0.0

*Percentages compiled for each group. For numbers of participants in each group, see p. 11.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions From the Various Sources

Many sources of information were studied in an attempt to determine the needs for draftsmen as affected by automation and as required for specialization in the major fields of engineering and architecture. These same sources were studied to learn of any implications for revision of curriculums in drafting in the junior colleges of California.

The needs of draftsmen were reviewed from responses to the check list as rated by the draftsmen and their supervisors. The supervisors' questionnaire provided information about the automated drafting devices in current use at their companies, the anticipated additions of new automated devices and the draftsmens' responsibilities for using or working with this type of equipment.

The ratings by the draftsmen and their supervisors of specific skills used by detailers and designers provided information on the comparative needs of draftsmen at different levels and in different fields. The opinion survey provided additional information on automation, specialization and training needs as expressed by the draftsmen and supervisors.

The surveys of the junior colleges in California provided information from deans and instructors on the types of drafting programs currently offered, and the general course requirements under the various programs. The interview with drafting instructors provided information on the same skill items rated by the draftsmen as these items were emphasized in the specialized courses the instructors taught. The opinion questions at the end of the check list were helpful in obtaining expressions on the needs for curriculum revisions. Informal conversations with drafting management personnel, as well as those interviewed were most helpful in verifying the formal responses or in applying them to present and future needs.

Conclusions Regarding the Effects of Automation on the Needs of Draftsmen

A review of the results of the junior college survey showed some minor implications for automation as the junior colleges reflect the needs of industry. Of the twelve different types of drafting courses added during the last three years, only one college reported a course in computer drafting. None of the other titles for new courses suggested any automated drafting. No mention was made of automated drafting in response to the related courses required in the various drafting programs.

The review did show, however, that eight of the sixty-seven colleges offered some form of course in drafting for numerical control, data processing, or computer graphics that would be at least recommended for the drafting students. Some colleges indicated that these topics were included in advanced drafting courses. Four of the colleges reported having automated drafting devices on campus at the time of the study and more indicated an intention to provide some in the near future. In response to the question of the colleges' plans for new drafting courses to be offered, three colleges plan to offer courses in computer aided graphics, two plan to offer drafting for numerical control.

A review of the responses to the questions on the junior college survey would indicate that the colleges were considering the need for course revisions carefully. With the assistance of their drafting advisory committees they were studying the equipment used in industry and the needs of draftsmen for training in the various devices. There did not appear to be any overt action toward whole new programs or courses for automated drafting, but rather the incorporation into existing courses of whatever changes were deemed advisable and feasible by all concerned.

A review of the interviews with draftsmen in industry revealed little need for new skills or knowledge for the use of automated devices. The supervisors stated that the draftsmen had little if any contact with the automated equipment and whenever training for it was needed it could be done on the job.

Conclusions Regarding the Need for Specialization in Drafting

The responses from the 81 public junior colleges in California showed that 67 offered some type of drafting program. The five major types of specialized drafting programs listed in the questionnaire were those most frequently reported in addition to general drafting. Other specialized drafting programs were listed by 7 of the colleges, but none by more than one college.

New drafting courses added within the last three years suggested specialized offerings in the five major areas and courses in "tool drafting," "aircraft drafting," "sheet metal drafting" and "optics drafting." Considerable generalization of program content was suggested by the colleges that included in their drafting programs, courses in the traditional engineering drawing and descriptive geometry with additional specialized courses for the options. A certain amount of specialization in the drafting programs was indicated by the varying amounts of related courses required in each of the specified major options but this could have been the results of local curriculum design or departmentalization.

Using the colleges' responses on advisory committees as an indicator showed that it was not uncommon for colleges to have special drafting advisory committees in the major fields. In response to the new drafting courses planned by the colleges, courses in all the major options were listed as well as courses in "map drafting' and "oceanographics."

There appears to be a wide spread practice of reliance on the traditional courses of engineering drawing and descriptive geometry for the basic preparation of draftsmen with selections of specialized courses in various technologies to form option programs. Considering the junior college's function of providing transfer courses for the four-year engineering and technology program, and considering the appreciation and acceptance of these traditional courses on the part of drafting managers, there would seem to be sufficient reason to continue this practice in those situations where it satisfied the needs of local industries and suited the policies of the particular college.

A review of the interviews with draftsmen in industry revealed some need for specialization. However, the draftsmen expressed a need to be flexible enough to meet the demands for labor when reassignments of personnel are required for new projects or departmental changes.

Few indications of need for specialized skills were found in the responses concerning lettering methods, measurements or mathematics. The itemized requirements were needed by all groups in generally comparable proportions. None of the responses given suggested any need for specific skills by one group or patterns of skills that would represent a need for specialized training in these subjects.

The need for training in fundamentals of projection, good drafting technique, and the use of tools, materials, and sources of information was expressed by draftsmen in all areas. The common need for these skills would support the rationale of the programs that offer a common core for the first year and specialized option courses during the second year.

The greatest amount of specialization noted in the responses to questions on blueprint reading, detail and design drafting was in the field of civil drafting. There would appear to be some specialists in mapping who have little need for other fields of drafting. The ratings of needs by electronics draftsmen and mechanical draftsmen compare more favorably with each other than either group does with any of the other groups in the study. The ratings by architectural draftsmen compare more closely to the ratings by structural draftsmen than do the ratings of either group with any of the other groups.

Specialization in drafting, then, might well be limited to training in combinations of two related major fields such as electromechanical, civil-structural or architectural-structural as would suit the interests and abilities of the draftsman. Many draftsmen stated that the student who would try to limit his training so as to specialize in only one area would be handicapped in finding a job and in being placed during times of reassignment.

Conclusions Based on Informal Discussions

Informal discussions were invariably held with managers, supervisors, and draftsmen at the time of the arrangements for visits to industries and professional offices and during the less structured portions of the interviews. These discussions lead to many conclusions or speculations, regarding automation in drafting. While much of the information offered at these times was based upon opinions, many of the opinions were the results of ideas and plans expressed by persons in administration, engineering and drafting management and consitute the best educated guesses available. These conclusions then, form a summary of informal responses that may be applicable in some situations, and may have no meaning whatever in others. Some of the conclusions will find support from the draftsmen and supervisors in their responses to the formal parts of the interviews. Others will be outside the topics of the directed questions, but will be more or less related to the needs of draftsmen and the nature of drafting work now and in the future as well as the needs can be foreseen by those in drafting positions at this time.

The Effects of Automation on the Various Fields

The effects of automation on drafting will be seen in some fields sooner than others largely due to the nature of the work that may or may not lend itself to programming. Considerable work has been done in the electronics field with programmed designs for printed circuit layouts, integrated circuits, and logic diagrams. The computer's ability to solve complex problems is being used in civil engineering to plan roads with maximum economy of cut and fill operations and maximum safety in design for high speed travel. In mechanical engineering the computer has been used effectively in designing impellers and other complex shapes and in digitizing loft lines and planning dies for automotive body production and tire tread molds.

Less use of the computer was seen in the structural and architectural fields. Although it has been found effective in planning, scheduling, and recording progress on projects and in various applications of administration of the business it has not had any considerable impact on the nature of the work of the draftsman. Some of the applications that might be expected soon in architectural and structural work will be the storage of data for greater accessibility and more range in research of products and structural practices. The design work in architecture seems at this time to be about the last possible use of computer aided design. Architects explained that because of the uniqueness of each project and freedom of selection of building materials and the infinite arrangements and compositions for designs of single buildings and complex systems and with the ever present objective of aesthetic appeal that it will be some time before these variables can be effectively programmed for computer aided design. The computer will be valuable for complex structural problems and routine office work but not readily adapted to creative design.

Drafting Operations Performed by the Engineers

The effects of automation will be most noticeable in the near future in regard to the drafting work performed by the engineers. Less drafting will be done by engineers as their training will not include the highly developed skills they needed in the past. Their time will be too valuable to perform the graphical solutions of problems that can be programmed for the computer, when it can solve and produce a printout of the data in alphanumeric form or graphic plots and with greater speed and accuracy. Much of the fine line work and lettering techniques used in civil drafting and formerly done by engineers can be done by technicians with improved pens and materials so that the training needed to develop mastery of technique will not need to be a part of the engineer's education.

The computers can experiment with numbers of slight variations for design studies so much faster than humans can that increased exploratory studies leading to optimization is possible. The computer aided plotters will relieve the engineer of much of his layout drafting and design duties and enable him to devote more of his time to problem analysis and conceptual design, leaving the functional design and development of working drawings for the technician.

The graphics training for engineers will be devoted to problem solving techniques that will be suited to automated processes. Their graphics knowledge will serve them for the purposes of communications and documentation more than for the development of drawings.

Drafting Work Performed by the Beginning Draftsmen

In the future less copy work and tracing will be done by the junior draftsmen. In the past much use has been made of apprentice draftsmen with little or no formal schooling in drafting to trace worn out, torn or otherwise unusable vellums on which the information was still valuable. Modern reproduction equipment makes it possible to produce new transparent masters of drawings omitting much of the dirt, fractures, stains and other blemishes that make the old vellums unusable. Future improvements in reproduction equipment will reduce the need for the time consuming tedium of copying drawings.

The new equipment and processes used in the "cut-and-paste" or "scissors" drafting applications will reduce the amount of work done by apprentices in preparation of new drawings which incorporate much of the design and information of existing drawings. Instead of tracing or copying selected views or notes from old drawings new techniques of cutting up previously made drawings, to get usable parts, combining them with the new information to compose a new drawing, and mechanically making a reproducible master will save considerable time and produce drawings for more immediate use at a lower cost. The modifications of brown lines and other intermediates and the use of preprinted adhesive materials and typewritten notes will also reduce the amount of tedius copy work and tracing for the apprentice draftsmen.

It might be pointed out in passing, however, that this use of beginners to trace old drawings and copy usable information from existing drawings has been of value for the training of inexperienced personnel. The tracing of drawings has helped not only in the development of technique and appreciation of drafting room standards and practices required on the job but also as an orientation to the company's products, operations, and practices elsewhere in the preparation and use of the drawings. If drafting managers make it a policy of hiring more experienced draftsmen, the new men will need less time to familiarize themselves with the idiosyncrocies of the new company, new department, or project. However, the time that is needed for a break-in period will be purchased at a higher rate for the more experienced draftsman. It might be well to note also that if less training is to be done on the job it might be expected that more will have to be done by the schools.

Scissors drafting may not be considered as automatic drafting since it is not electronically controlled, but it makes drawings at a faster rate than the draftsman, so it might be grouped with labor-saving devices that speed up the system of drawing production, and it may have considerable effect on industry's needs for beginning draftsmen.

Drafting Work Performed by the Technician

With fewer engineers doing their own layout and detail drawing and fewer apprentices employed for routine copying and tracing, it would be reasonable to expect that the drafting work will be done in the near future by a more highly trained middle-level technician. Less computational work will be done with logarithms and slide rules, more will be done by calculators and computers. The draftsman will be expected to use hand books of mathematics formulas and engineering data to solve drawing board problems. More draftsmen will have the use of a calculator even if shared by several others. At present the calculation requiring the capabilities of the computers are almost entirely the responsibility of the engineers. The draftsmen does not operate the computer or even prepare work for it to any great extent. It would appear from the interviews in this study that the use a draftsman might make of the computer would not be complicated enough to require him to know a programming language. Some use was observed of predesigned problem sheets which require the user to simply fill in the blanks with variables for the particular problem. These were very useful in solving problems that were typical in the company's operation and used frequently enough to warrant the cost of prepared programs and routines.

The drafting technician of the future will need a better understanding of basic production processes. He will find it most helpful to have worked in the shops for mechanical and electronics production and in the field for architeture, civil and structural projects. The informal remarks of drafting personnel as well as the responses on the survey indicated a need for instruction in applied technologies in college shops and laboratories.

Advancing technologies will bring new products and processes to the attention of the draftsmen. Knowledge of existing materials and methods will help him appreciate the new ones and enable him to keep up to date in the application of them on the drawings he makes. Advanced techniques of data aquisition will make the search of source material more extensive and more rapid. The use of the information thus found will require a more thorough understanding of the materials, processes and professional practices in the field of the draftsmens' discipline.

Recommendations

From the conclusions of this study there would appear to be little need for revisions to the curriculums of those drafting programs that are up to date in every other way to make them suited to the training of draftsmen for automation. The recommendations that would seem most important at this time would be for instruction that would provide the student with an understanding of the place of computer-aided design and automated drafting in the total scheme of research, development, documentation and production along with the draftsman's responsibilities in these areas.

The basic skills and knowledges of drafting, mathematics, science, and related technologies as taught by most colleges would seem to be adequate for the draftsman to begin work and make progress on the job. The more specific skills and knowledges of the operation of any automated device or the language of man-machine communications can be learned when it is known what systems will be needed for the equipment used in a particular firm or department.

Recommendations for Curriculum Revisions. There appeared to be strong recommendations for continued emphasis on the basic skills of drafting from all levels of drafting personnel. The fundamentals of layout and projection of views, sectional and auxiliary views, dimensioning and notes, materials and processes, will all be as important to the draftsman's work whether he is using a T-square and triangle, a drafting machine, or a plotter.

The need for mathematics expressed by the draftsman supports the recommendations that all drafting programs should include mathematics through trigonometry. Whether the traditional course pattern of algebra, geometry, advanced algebra, and trigonometry, or a technical mathematics course including applied trigonometry that would satisfy the needs of the technician should be offered might be subject to other considerations of needs at the particular college. The offering in physics or physical science, in a similar way, might consist of the regular courses offered for other programs in the college, or it might be taught as part of a multi-unit block of drafting technology. The recommendation, here would not be for any particular plan, but instead, for the instructor to be certain that the drafting student is neither required to take the mathematics and physics courses offered in the engineering transfer program, nor be allowed to complete a vocational drafting program without the exposure to the mathematics and physics needed by the draftsman.

Recommendations concerning specialization would favor a broad base of general drafting in the first year with special courses forming the option program during the second year. The specialization of the option should be broad enough to train a student in two major disciplines as electro-mechanical, architectural-structural, or other combinations of related fields.

The recommendations of draftsmen that instructors should be vocationally oriented and they should make instruction as much like the job situation as possible are some that the teachers should consider in their regular self-evaluation. The need to keep up with industry and bring industry into the classroom can not be overemphasized in vocational programs. Part-time and summer employment, visits to industries, institutes, in-service training programs, and guest speakers all help to keep the course work consistent with industrial practices. Other recommendations on this subject might be to those colleges that do not have active advisory committees to investigate this plan for possibilities of coordinating their programs with the needs of local industries. Educators will find rewarding experiences in the associations with members of professional organizations for architecture, drafting, engineering, and specialized technical societies for the mutual assistance of industrial and professional offices and educational instutions.

The drafting technician of the future will need a better understanding of basic production processes. He will find it most helpful to have worked in the shops and laboratories for mechanical and electronics production, and in the field for architecutral, civil, and structural projects. The informal remarks of drafting personnel as well as the responses on the survey indicated a need for instruction in applied technologies in college shops and laboratories. Advancing technologies will bring new products and processes to the attention of the draftsman. Knowledge of existing materials and methods will help him appreciate the new ones and enable him to keep up to date in the application of them on the drawings he makes. Advanced techniques of data acquisition will make the search of source materials more extensive and more expeditious. The use of the information thus found will require a more thorough understanding of the materials, processes and professional practices in the field of work. Some suggestions from drafting personnel have indicated that the schools and colleges may be able to do more in preparing the draftsman for the expanding use of information. Drafting managers and others have recommended that draftsmen should be instructed more in the methods of researching information, using various forms of tables and charts, catalogs of products, standards, and specifications. With more information available, draftsmen will need to know how to make better use of it.

Recommendations for Further Studies. From the acceptance of this project and the interest in practical research expressed by the deans and instructors in colleges, the managers and draftsmen in industry, and the advisors on the design and procedures of this study, it would seem that there remains a great need for further investigation in this area. Additional studies should be made to learn in greater detail the needs of the draftsmen in the various specialized areas. It would be helpful to have more discriminating data on the needs of draftsmen in the major fields and to determine the needs of those in the newer or lesser known areas. Such discriminating data would be more useful in course content evaluation if the behavioral objectives of the courses could be compared with the levels of skills and the extent of competency required for the various functions of the draftsmen.

The fact that this study found little use of automated equipment on the part of the draftsmen does not mean that they will not be using some of the devices in the near future. Much of the work currently done on automated equipment is for the purpose of research and investigation into the best applications of it and the development of soft-ware to prepare it for the needs of the particular company or department. As the equipment becomes more plentiful, less expensive, and more versatile, more use of it will be made. Whether the expanded use will include the operations of the drafting room or be more effective for functions of the engineers and administrators remains to be seen. Continued study of the developments of new types of plotters, digitizers, diagrammers, and systems of computer-assisted cathode ray tubes and light pens, and their applications in the drafting functions will be needed. If they become available in quantities and at costs commensurate with their capabilities their use will no doubt increase. Drafting instructors would want to be informed on the developments and uses of the new equipment whether it is used by the draftsmen themselves or by other members of the team of research, administration, design, documentation, and production, so as to know how to adapt the new information to their drafting courses.

Further research should be conducted perhaps as joint projects of the professional societies and educational institutions or coordinating offices. These research projects should provide more information to instructors who are unable to obtain personal experience in as many fields as they might want to, and to provide information to drafting managers regarding training programs available to their apprentices, and regarding sources of newly trained personnel. Most of all, however, the information should be useful to students who want to know more about the training requirements and job needs of draftsmen as an aid to making their decisions on which courses to pursue for a challenging and profitable entry into the world of work.

BIBLIOGRAPHY

Burt, Samuel M., "A Three-Year Program for Your Advisory Committee," _American Vocational Journal_, September, 1968.

Gardiner, John, "Quality of Higher Education," _Junior College Journal_, May, 1968.

Garrison, Roger, _Junior College Faculty: Issues and Problems_, Washington: American Association of Junior Colleges, 1967.

Peterson, Basil, _Critical Problems and Needs of California Junior Colleges_, California State Department of Education, Sacramento: 1965.

Roueche, John, "Gaps and Overlaps in Institutional Research," _Junior College Journal_, May, 1968.

Squires, Carle E., _Current Practices Observed in Design and Drafting Occupations_, Glendale Community College, Glendale, Arizona, 1966.

Swanson, Chester, "Can We Carry Out the 1963 Mandate for a Total Program?" _American Vocational Journal_, September, 1968.

Technician Need Study: Vermillion County, Illinois, A study conducted by the University of Illinois, Urbana, Illinois, 1964.

APPENDIX A

MATERIALS FOR THE SURVEY OF JUNIOR COLLEGES

A-1 Letter to the Deans
A-2 Return Form
A-3 Survey Questions
A-4 Second Letter to the Deans

CITRUS COLLEGE
CITRUS JUNIOR COLLEGE DISTRICT
18824 EAST FOOTHILL BOULEVARD
AZUSA, CALIFORNIA 91702
TELEPHONE 335-0521

BOARD OF TRUSTEES
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PRESIDENT
AND DISTRICT SUPERINTENDENT

Under a federally funded research project, Citrus College and the Vocational Education Department at U.C.L.A., are jointly sponsoring a study of the current programs for the training of draftsmen in specialized fields in the junior colleges of California.

This study began in September, 1968, and will continue throughout the school year 1968-69. We would like to ask your cooperation on this project and hope to make it as convenient for you as possible by letting you know in advance of our plans.

First, we would like to ask for the name of your director of Vocational Education and/or department chairman or drafting instructors who would be cognizant of the information we are attempting to collect.

Second, we would like to ask you to complete the enclosed questionnaire on the drafting program offered at your college.

Third, we would like to ask your support and your encouragement to your staff to participate in the more detailed course content survey by mail that will follow in the next few weeks. We are also planning to visit representative junior colleges from January to March and hope to have your cooperation at that time.

This project has been approved by the State Board of Vocational Education. The Bureau of Vocational-Technical Education of the Community Colleges of California is supporting it as a means of developing new guidelines for improving instruction in drafting.

We greatly appreciate your cooperation on this study and look forward to visiting with you later this year.

If you have any questions or suggestions please contact the project director.

Sincerely,

William T. Husung, Jr.
Project Director
Citrus College Drafting Study

Serving the Community Since 1915

CITRUS COLLEGE VOCATIONAL DRAFTING STUDY

QUESTIONNAIRE ORIENTATION

General information regarding the Study of Vocational Drafting Training in Junior Colleges in California.

A. The advent of automation has produced confusion and anxieties over the status and needs of the draftsman.
B. The American Institute for Design and Drafting recently predicted that 212,000 new draftsmen will be needed in this country by 1975.
C. Engineering majors no longer meet the needs for draftsmen as drafting has been almost eliminated from their curriculum.
D. The training of draftsmen will become increasingly the responsibility of the vocational-technical programs of the junior colleges.
E. Drafting jobs can meet the needs of a problematic segment of our society for white-collar status in professional-technical employment.
F. Increased diversity and specialization in drafting jobs demand the identification of cluster courses and specialized optional training in the various programs and levels of drafting instruction.

THE OBJECTIVES

The purposes of this study will be to determine:
A. The extent to which current practices in training are responsive to current needs of draftsmen in industry.
B. The effects of automation on the needs of industry for draftsmen with general vs. special training, both for entry and advancement.
C. The curricular revisions in vocational drafting programs in California junior colleges to meet the needs of draftsman.

The Nature of the Project

Selected industries throughout California known to employ draftsmen will be surveyed and approximately 1% of the 22,000 draftsmen in the State will be interviewed along with their supervisors to determine the effects of automation on the nature of their jobs and on the training needed for them.

A survey of all the junior colleges in California will be made and 20 will be selected for visits to determine the effects of automation on the instructional programs for draftsmen, and their plans for specialized drafting options and other curricular revisions.

In answering questions on this questionnaire it will be understood that in many junior colleges draftsmen are trained along with pre-engineers and take courses that are called any of the following; engineering drawing, descriptive geometry, advanced engineering drawing, technical drawing, industrial drafting and graphics. As these courses are usually general in emphasis and equally applicable to several specialized fields, please consider them as General Drafting unless they are designed for a specific option or unless they are mentioned separately in a particular question.

The results of this project should prove useful to junior college instructors who are concerned with meeting the ever-changing needs of the drafting profession. Summaries will be available upon request.

CITRUS COLLEGE DRAFTING STUDY

Please return this sheet with the questionnaire

1. The names of our personnel who are familiar with the course content of the drafting programs are:

   Director of Vocational Education or similar title or position: ____________

   Department Chairman: ____________

   Drafting Instructors: ____________

   General: ____________

   Mechanical: ____________

   Architectural: ____________

   Civil: ____________

   Structural: ____________

   Electronics: ____________

   Others: Name and field: ____________

2. I am returning the completed questionnaire. ________

3. The person to contact to arrange a visit to our institution during school hours is:

____________	____________	____________
Name	Title	Phone

I would like to receive a report of the findings of this study

Yes _____ No _____

A-2

CITRUS COLLEGE VOCATIONAL DRAFTING STUDY

QUESTIONNAIRE

RESPONDENT____________________________ INSTITUTION ____________________________

To be completed by the Dean of Instruction, Vocational Director, Department Chairman, or Drafting Instructor.

1. Which of the following programs in Vocational Drafting are offered at your institution:

Options	Not at all	As a course of study for an AA Degree	As a certificate program less than AA	As a trade related course	Other*	Available Days	Available Nights
Gen. Draft.							
Mech. Draft.							
Struct. Draft							
Arch. Draft.							
Civil Draft.							
Elect. Draft.							
Others							

*Explanation of "other" programs in Vocational Drafting:

2. Please check the approximate number of students enrolled in and completing (certificate, A.A., etc.,) the Drafting Programs in Spring 1968:

	APPROXIMATE NUMBER OF STUDENTS ENROLLED IN SPRING 1968										APPROXIMATE NUMBER OF STUDENTS WHO COMPLETED IN JUNE 1968				
	1st Year Program					2nd Year Program									
Options	0	1-14	15-29	30-50	Over 50	0	1-14	15-29	30-50	Over 50	0	1-14	15-29	30-50	Over 50
Gen. Dr.															
Mech.															
Struct.															
Arch..															
Civil.															
Elect.															
Others															

3. Has your college added any specialized drafting courses in the last 3 years?

   A. Yes ______ No______

   B. If Yes, please name them.

4. What is the highest level Math. course required as a prerequisite to entering each of the special programs?

Option	None	Tech. Math.	Alg.	Geom.	Adv. Alg.	Trig.	Other
Gen. Dr.							
Mech. Dr.							
Struct. Dr.							
Arch. Dr.							
Civil Dr.							
Elect. Dr.							
Others							

5. What Math. competencies are included in the drafting training program?

Please check the Math. courses or competencies required in each field.

Options	None	Tech. Math.	Alg.	Geom.	Adv. Alg.	Trig.	Anal. Geom.	Calculus	Other
Gen. Dr.									
Mech. Dr.									
Struct. Dr.									
Arch. Dr.									
Civil Dr.									
Elect. Dr.									
Others									

6. What prerequisites in drafting are expected of students entering the various programs?

Options	None	1 yr. H.S. Mech. Dr.	2 yrs. H.S. Mech. Dr.	H.S. Arch. Drafting	H.S. Elect. Drafting	Other
Gen. Dr.						
Mech. Dr.						
Struct. Dr.						
Arch. Dr.						
Civil Dr.						
Elect. Dr.						
Others						

7. How many units of each of the drafting courses are required of students to complete the programs in the various options?

For courses that might combine two or more areas in one course of many units please describe it as divided into units proportionally to the amount of each area covered, e.g. Electro-mechanical Drafting, 7 units, might be 3 units electronics drafting and 4 units mechanical drafting.

DRAFTING COURSES

Options	Mech. Draw.	Eng. Draw.	Desc. Geom.	Adv. Eng. Draw.	Arch. Draft.	Struct. Draft.	Civil Draft.	Elect. Draft.	Tech. Ill.	Art	Other
Gen. Dr.											
Mech. Dr.											
Struct. Dr.											
Arch. Dr.											
Civil Dr.											
Elect. Dr.											
Others											

8. How many units of related courses are required of students to complete the program?

RELATED COURSES

Options	Mach. Shop or Metals	Mat'ls. Lab.	Surveying	Physics	Chem.	Indus. Processes	Others
Gen. Dr.							
Mech. Dr.							
Struct. Dr.							
Arch. Dr.							
Civil Dr.							
Elect. Dr.							
Others							

9. Are Drafting majors required to take a course in "Introduction to Engineering" or "Professional Practices"?

Yes _____ No _____ Name of Course ____________________________ Units_______

10. Do you offer any courses in "Drafting for Numerical Control", "Computer-aided Drafting", "Data Processing" or other specialized courses that may or may not be required but are at least recommended for draftsmen? Please list

11. Do you have any work experience or work study programs for training draftsmen on the job? Yes_____ No _____

If yes:

A. Approximately how many students participated in such a program in the Spring 1968? ________

B. How many hours per week is spent on the job by these students? ____________
How many hours in the drafting classroom? __________________

12. Do you have advisory committees for the special fields or a general drafting advisory committee?

A. No Drafting Advisory Committee _____

B. General Drafting Advisory Committee ____

C. Special Drafting Advisory Committee in these areas:

13. What experiences do students in drafting programs have with the following items of equipment?

EQUIPMENT	None	STUDENTS USE IT THEMSELVES On Campus	 Off Campus	STUDENTS SEE IT USED On Campus	 Off Campus
Computer aided cathode ray tube and light pen system					
Computer aided plotter					
Digitizer					
N/C machining tools					
Tape puncher					
Microfilm cameras					
Microfilm readers					
Microfilm printers					
Other Items:					

14. What use is made of field trips to industries to see or use the equipment in question 13?

15. What work experience programs provide training in the use of the equipment in question 13?

16. What plans do you have for new offerings in drafting?

17. What recommendations have been made by your drafting advisory committees that will change your programs in the near future?
    A.

    B.

18. Placement and follow-up of drafting students
    A. Is instructor expected to contact industries for placement of students
       Yes _____ No _____
    B. Do you have a placement counselor other than instructors or education counselors who work with industry personnel to place students?
       Yes _____ No _____
    C. Who has the most responsibility for placement of students? _______________
    D. Who has the responsibility for follow-up of students placed in drafting jobs? ____
    E. Do you use a follow-up card or return letter system to check progress of newly hired draftsmen? _______________________________________
    F. Do you also get information on effectiveness of your program this way?
       Yes _____ No _____

19. Do you have brochures describing the drafting program offered at your school?
    Yes _____ No _____
    A. If so, does the brochure describe specialty options in the drafting program? Yes _____ No _____
    B. Does the brochure refer to the effects of automation on the drafting program? Yes _____ No _____

20. Do you offer any programs in drafting for students with special needs, i.e. retraining, remedial work, physically handicapped. Yes _____ No _____
    Please describe briefly.

Dear Mr. ________

On December 9, 1968, a copy of the Citrus College Drafting Study was sent to each of the junior colleges in California. The planning was timed with the strategy that some administrators would respond within the week, others would put if off until desk cleaning time over the holidays. Some questionnaires were probably passed on to subordinates who might have had more information on the particulars of the study, and unfortunately some of the questionnaires may have been lost or thrown out.

Whatever the disposition of the survey set you were sent, may I ask you to give it a second thought and take the time to remind the subordinate or to complete it yourself and return it to me as soon as possible.

This study has received good support so far and almost enough questionnaires have been returned to enable me to complete the data processing and prepare the reports to the State Bureau of Vocational-Technical Education and the U.S. Office of Education. However, in the interest of reporting as much factual information as possible, I would not like to overlook or be forced to omit any drafting programs currently offered in any of the California junior colleges.

For your convenience, I am enclosing a complete duplicate set of the survey materials mailed out in December. If you have returned the first set so recently that I have not received them by the time this second set is mailed, I want to thank you and ask that you overlook my impatience, and forgive my misapprehension of what appeared to be a need for a reminder.

Your prompt attention and consideration in this matter will be greatly appreciated.

Sincerely,

William T. Husung, Jr.
Project Director
Citrus College Drafting Study

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Encl.

APPENDIX B

MATERIALS FOR THE INTERVIEWS WITH DRAFTSMEN IN INDUSTRY

B-1 Letters to Drafting Managers
B-2 Information to Participating Drafting and Design Facilities
B-3 Instructions for the Selection of Participants
B-4 Letter to the Participants
B-5 Personal Information Cover Sheet
B-6 Supervisor's Questionnaire
B-7 Supervisor's Information Sheet
B-8 Check List of the Draftsman's Duties

Dear Mr. ______

Please find enclosed the packet of materials explaining the study on drafting technicians I introduced to you over the phone. In this packet you will find some background information on the proposal of the project as approved for funding by the U.S. Office of Education, a set of the questionnaire forms to be used in the interviews, and information regarding the selection of participants.

Various reports of this study will be made to the U.S. Office of Education, The State Bureau of Vocational-Technical Education and to the Department of Vocational Education at UCLA. Summaries of the findings will also be written for national magazines on graph ics and education. In all these reports your firm will be acknowledged as a contributor to the study, but only general references will be made to the companies and the responses of individual participants will be kept confidential.

I hope that you will find this to be an interesting and valuable survey with results that will serve to keep educators informed on the needs of draftsmen and that it will aid in the advancement of the drafting profession.

If after reviewing these materials you find it possible to support this study by enabling me to interview draftsmen in your offices, we can discuss further arrangements when I call on January 27.

If you have any questions, please call me at Citrus College, 213-335-0521, Ext. 368.

Very truly yours,

William T. Husung, Jr.
Project Director
Citrus College Drafting Study

mpo

Encl.

CITRUS COLLEGE DRAFTING STUDY

Information to Participating Drafting and Design Facilities

The changes in the job functions and skills needed by draftsmen with the advent of automation and the specialization in the various fields of engineering, production, and design are among the topics presently being studied under a project funded by the U.S. Office of Education and approved by the California State Board of Vocational Education and The Department of Vocational Education at UCLA. The study has also received the support of the American Institute for Design and Drafting, a national professional association for drafting management and education.

One phase of the study consists of contacting California industries and professional offices in which automated drafting devices, ie., cathode ray tubes, digitizers, plotters, etc., have been introduced, and firms in which draftsmen are preparing drawings for machining or assembly by numerically controlled machine tools. In these companies, draftsmen and supervisors will be interviewed to learn how their skills and job functions have been effected by the implementation of this equipment.

The plan of the study is to visit a selected sampling of California professional firms and industries, chosen with regard to geographic area and field of engineering or production, so as to obtain the most representative cross section of the drafting profession. Further selection of the draftsmen to be interviewed has been worked out to assure similar representation in all companies. Since companies have varying job classifications and varying numbers of levels in their classifications from beginning tracers or detailers to experienced designers, it was decided that designations such as "middle range detailer" and "middle range designer" would produce two sets of draftsmen at levels that would be comparable in any plant regardless of the company's method of classifying draftsmen. (See page 2 for selection of participants.)

Enclosed for your further information is an abstract of the proposal of the study and a set of the survey forms to be completed by the supervisors during the interview. The draftsmen will respond to the same check list with a different cover sheet for more personal background information, (also enclosed). These forms should provide an introduction to the nature of the study and more details can be worked out over the phone.

The plan is to visit your plant within the week after the participants have been notified and meet with them in a conference room near their work stations either 5 or 10 at a time for about 30 minutes. With this kind of preparation, the most useful information can be obtained with the least interruption to your organization.

The cooperation of each company in this project is sincerely appreciated. In designing this study, considerable care was taken to obtain the information with the least interruption to the company's work schedule. The project director would have preferred to visit with the managers to introduce the project and perhaps assist more directly with the selection and preparation of the participants. However, the scheduling of meetings and even phone calls can be so time consuming that it was considered best to present the entire plan early and work out as many details as possible beforehand, so the managers would know the full extent of their involvement and the need for phone calls and extra trips to the companies could be minimized.

THE SELECTION OF PARTICIPANTS

In order to provide a representative sample, each firm is asked to select their participants on the following bases. First, in order to randomize the samples, they will select 2 detailers in 2 different fields or job areas such as 2 electronic detailers and 2 mechanical detailers. With all the similar detailers' names listed alphabetically, they will select the one that would fall at one-third the number from the top of the list and the one that would fall at two-thirds of the number from the top of the list. As an example, if there were 12 names on the list of middle range mechanical detailers, numbers 4 and 8 would be selected; if there were 30 names on the list, numbers 10 and 20 would be selected. In this way a completely impartial selection is made and every draftsman has the same chance of being selected. In the same way, 2 middle range designers will be selected from the same two fields as the detailers, (mechanical and electronics).

Then second, to complete the sample of ten participants to be interviewed each firm will select 2 supervisors, preferably the supervisors of some of the draftsmen selected above. So those interviewed at one firm would be: 2 electronics detailers, 2 electronics designers, and 1 electronics drafting supervisor, 2 mechanical detailers, 2 mechanical designers and 1 mechanical drafting supervisor.

While this method of selecting the participants may seem overly complicated, it is necessary to insure consistency of respondents for the classification of data, and to provide an unbiased sample of participants.

Personnel selected on the above bases to be participants in this study:

		Names	Plant Address
Mechanical Detailers	1.	______________________	________________________
	2.	______________________	________________________
Mechanical Designers	1.	______________________	________________________
	2.	______________________	________________________
Mechanical Drafting Supervisor		______________________	________________________
Electronics Detailers	1.	______________________	________________________
	2.	______________________	________________________
Electronics Designers	1.	______________________	________________________
	2.	______________________	________________________
Electronics Drafting Supervisor		______________________	________________________

To: Date:
Subject: Citrus College Drafting Study

Under a research project sponsored by the U.S. Office of Education and coordinated by the Vocational Education Department at U.C.L.A., a sampling of draftsmen and supervisors in 30 of California's leading industrial corporations are being interviewed to learn the effects of automation on the work of the draftsman. Information on this topic is vitally needed by drafting teachers in high schools and junior colleges in order to keep up to date on the needs of draftsmen in industry.

You have been selected by an impartial method from a group of draftsmen judged most able to provide the needed information on the training of draftsmen. We hope that you will be able to help us through this study to develop better training programs for the future and avoid some of the difficulties encountered by young draftsmen in the past.

Mr. William Husung, drafting instructor at Citrus College, will be interviewing the participants in this study from your department.

Date________________________

Time ________________________

Place ________________________

We will attempt to schedule your interview, not to exceed 30 minutes so as not to inconvenience you or interupt your work any more than necessary. You may be assured that your responses will be kept in strict confidence. We have no intention of embarrassing anyone or effecting his present job situation.

Your cooperation in this study will be greatly appreciated and we feel that the results of the project will be a real contribution to the drafting profession.

____________________________ ____________________________

William T. Husung, Jr.
Director of the Study

CITRUS COLLEGE DRAFTING SURVEY

PERSONAL INFORMATION

Company ______________________________ Date________

Division or Department ______________________ Age ________

Name of Respondent _________________________ Sex ________

Job Classification _________________________

Number of years in drafting jobs ______________

Length of time in present classification ________

Training for your present job_______________

Major in High School ___________________

Number years High School Drafting __________

* Number years Junior or Community College _____

Major ______________________________

Number years Technical Institute __________

Major ______________________________

Military Service Schools _________________

Correspondence Schools __________________

On-the-job training ____________________

Other types of preparation ________________

B-5

CITRUS COLLEGE DRAFTING STUDY

Part I

Survey of Drafting Supervisors to Determine the Effects of Automation on Their Needs for Draftsmen.

1. What automated drafting equipment do you have in your plant at present?

____

____

2. Do draftsmen or designers operate this equipment? ______________

3. If not, what is the job classification of those who do operate it?

____

4. What training or background did they need to start on this job?

____

5. How much training was provided by your company? ______________

By the manufacturer or the equipment? ______________

By others, (where was training obtained)? ______________

6. Have these machines reduced the number of draftsmen you employ? ________
By about what percent? ________

7. Have these machines increased the number of draftsmen you employ? ________
By about what percent? ________.

8. Have they necessitated the retraining of draftsmen? ______________

9. Please estimate the number of draftsmen and the average number of hours of retraining involved in this program. ______________

10. What automated drafting equipment do you expect to put in within the next

year? ______________________________________

11. What training programs for draftsmen to use this new equipment do you

anticipate? ______________________________________

12. If draftsmen or designers do not operate the automated devices, what additional training do they need to coordinate their responsibilities with the capabilities of the automated equipment? ______________

____

NAME ______________________ COMPANY ______________________

TITLE OR POSITION ______________________ DEPARTMENT ______________________

B-6

CITRUS COLLEGE DRAFTING STUDY
Survey of Drafting Supervisors

________________________	________________________________
Supervisor's Name	Job Classification Surveyed

Directions:

You are being asked to respond to this check list as you interpret the importance of the skills listed below to the duties of the draftsmen in your charge. Your responses will be used to substantiate the responses of the draftsmen in your plant and to corroborate the responses of supervisors like yourself in other plants. You may use the same instructions and response keys to mark your questionnaire as you state your rating of skills needed by the draftsmen in your charge. Please identify the job classification you are describing as to level and field; i.e. detailer or designer in mechanical, electronics, civil, etc.

This one-third sheet of additional instructions for the supervisors was stapled in their questionnaire forms after the first page to explain to them their responsibilities for responding according to the needs of draftsmen in their charge, and to emphasize the precise identification of the job classification surveyed.

SURVEY OF THE DRAFTSMAN'S DUTIES

DIRECTIONS: Place a check in the appropriate column for each of the duties below to help us identify those skills that are more or less important to your job. Some of the items will be unrelated to your field, but careful consideration of each item will help us identify responsibilities that cross over more than one field.

Check the columns as follows:

0 For things you do not do
1 For things you do only occasionally
2 For things which you do more regularly, but which do not take much time, or which are a minor part of your work
3 For things which take major portions of your time, or which are a major part of your work
4 For things which take all, or almost all, your time, or things at which you are normally a full-time specialist
+ For things you wish had been covered more in drafting courses you took
- For things you have not needed from the drafting courses you took and could have been left out or de-emphasized. Don't try to check every item for these last two columns. Only those items that stand out in your needs should be checked.

Disregard the figures in the column at the far right, they will be used only for data processing.

R. ☐
T. ☐
L. ☐

1. Reading blueprints of:	0	1	2	3	4	+	-	
1. Mechanical details								1
2. Mechanical assemblies								2
3. Tool drawings								3
4. Installation drawings								4
5. Wiring diagrams								5
6. Electrical schematics								6
7. Electronic schematics								7
8. Printed circuit boards								8
9. Welded modules								9
10. Logic diagrams								10
11. Building plans, single story								11
12. Building plans, multiple story								12
13. Architectural details								13
14. Structural steel details								14
15. Structural steel diagrams								15
16. Maps or site plans								16
17. Piping diagrams								17
18. Piping parts and assemblies								18
19. Flow charts and diagrams								19
20. Pneumatic or hydraulic drawings								20
21. Plumbing, heating, air cond. plans								21
22. Sheet metal drawings								22
23. Welded fabrication drawings								23
24. (Other)								24
25. (Other)								25

2. Doing Design Drafting of:

	0	1	2	3	4	+	-	
1. Mechanical details								1
2. Mechanical assemblies								2
3. Tool drawings								3
4. Installation drawings								4
5. Wiring diagrams								5
6. Electrical schematics								6
7. Electronic schematics								7
8. Printed circuit boards								8
9. Welded modules								9
10. Logic diagrams								10
11. Building plans, single story								11
12. Building plans, multiple story								12
13. Architectural details								13
14. Structural steel details								14
15. Structural steel diagrams								15
16. Maps or site plans								16
17. Piping diagrams								17
18. Piping parts and assemblies								18
19. Flow charts and diagrams								19
20. Pneumatic or hydraulic drawings								20
21. Plumbing, heating, air cond. plans								21
22. Sheet metal drawings								22
23. Welded fabrication drawings								23
24. (Other)								24
25. (Other)								25

3. Doing Detail Drafting of:

	0	1	2	3	4	+	-	
1. Mechanical details								1
2. Mechanical assemblies								2
3. Tool drawings								3
4. Installation drawings								4
5. Wiring diagrams								5
6. Electrical schematics								6
7. Electronic schematics								7
8. Printed circuit boards								8
9. Welded modules								9
10. Logic diagrams								10
11. Building plans, single story								11
12. Building plans, multiple story								12
13. Architectural details								13
14. Structural steel details								14
15. Structural steel diagrams								15
16. Maps or site plans								16
17. Piping diagrams								17
18. Piping parts and assemblies								18
19. Flow charts and diagrams								19
20. Pneumatic or hydraulic drawings								20
21. Plumbing, heating, air cond. plans								21
22. Sheet metal drawings								22
23. Welded fabrication drawings								23
24. (Other)								24
25. (Other)								25

4. Lettering you do:

	0	1	2	3	4	+	-	
1. Freehand								1
2. Typewriter								2
3. LeRoy or similar								3
4. Pres-type or similar								4
5. (Other)								5

5. Sources of information you use:

	0	1	2	3	4	+	-	
1. Sketches by others								1
2. Oral instructions								2
3. Vendors' catalogs								3
4. Military standards								4
5. Corporation specifications								5
6. Trade standards								6
7. County or national codes								7
8. (Others)								8

6. Tools and equipment you use:

	0	1	2	3	4	+	-	
1. Drawing board and T-square								1
2. Parallel rule								2
3. Drafting machine								3
4. Slide rule								4
5. Calculator								5
Computer: work you do:								
6. (1) Prepare work to be punched								6
7. (2) Punch the cards								7
8. (3) Feed the cards to the computer								8
9. (4) Type data into the computer								9
10. Architect's scale								10
11. Machinist's scale								11
12. Civil engineer's scale								12
13. Templates								13
14. Planimeter								14

7. Measurements you use:

	0	1	2	3	4	+	-	
1. Fractional dimensions								1
2. Decimal dimensions								2
3. Inch-foot measurements								3
4. Metric measurements								4
5. Coordinate dimensioning for N/C								5
6. True position tolerancing								6
7. Surface quality symbols								7
8. Form tolerance symbols								8
9. (Others)								9

8. Materials you draw on:

	0	1	2	3	4	+	-	
1. Opaque paper								1
2. Vellum								2
3. Mylar or similar								3
4. (Other)								4

	9. Materials you draw with:	0	1	2	3	4	+	-	
1.	Lead pencil or lead holder								1
2.	Plastic pencil								2
3.	Ink								3
4.	Tapes and pads								4
5.	Scriber								5
6.	(Other)								6

	10. Mathematics you use:	0	1	2	3	4	+	-	
1.	Algebraic formulas								1
2.	Trignometric formulas								2
3.	Trignometric identities								3
4.	Logarithms, base 10								4
5.	Logarithms, other bases								5
6.	Calculus								6
7.	Nomograms								7
8.	Analytic geometry								8
9.	Descriptive geometry								9
10.	Handbooks of Math. tables								10
11.	(Other)								11

	11. Geometric constructions you use:	0	1	2	3	4	+	-	
1.	Constructions of polygons								1
2.	Construction of tangent arcs								2
3.	Construction of conic sections								3
4.	Construction of irregular curves								4
5.	(Others)								5

	12. Types of drawings you make:	0	1	2	3	4	+	-	
1.	One view drawings (schematics, charts, diagrams, graphs)								1
2.	Isometric sketches								2
3.	Scaled isometric drawings								3
4.	Perspective sketches								4
5.	Scaled perspective drawings								5
	Multiview projections								
6.	(1) Layout projections of multiviews								6
7.	(2) Sectional views of parts								7
8.	(3) Sectional views of assemblies								8
9.	(4) Single auxiliary views								9
10.	(5) Auxiliary views of auxiliary views								10
11.	(6) Removed and rotated views								11
	Intersections and developments								
12.	(1) Prisms and pyramids								12
13.	(2) Cylinders and cones								13
14.	(3) Triangulation of warped surfaces								14
	Gears and cams								
15.	(1) Make detail drawings								15
16.	(2) Layout assembly drawings								16
17.	(3) Calculate gear and cam sizes from formulas and parameters								17
	Screw threads and fasteners								
18.	(1) Symbols of screw threads								18
19.	(2) Details of screw threads								19

12.	Types of drawings you make (Continued)	0	1	2	3	4	+	-	
	For N/C machining or assembly								
20.	(1) Make drawings with special dimensions								20
21.	(2) Write programs for N/C								21
	Prepare drawings for input to:								
22.	(1) Computer								22
23.	(2) Digitizer								23
24.	(3) Diagrammer								24
25.	(4) (Other)								25

13.	Use printout information from:	0	1	2	3	4	+	-	
1.	Computer								1
2.	Digitizer								2
3.	Diagrammer								3
4.	(Other)								4

14.	Languages you use:	0	1	2	3	4	+	-	
1.	Fortran								1
2.	Algol								2
3.	Cobol								3
4.	Adapt								4
5.	(Other)								5

15.	Reproduction equipment you use yourself:	0	1	2	3	4	+	-	
1.	Blueprinter / whiteprinters								1
2.	Xerox copiers or similar								2
3.	Microfilm cameras								3
4.	(Others)								4

16.	"Scissors drafting" techniques you use	0	1	2	3	4	+	-	
1.	With blueprints or whiteprints								1
2.	With brownlines								2
3.	With Xerox or similar copies								3
4.	With photo prints								4
5.	With adhesive symbols, etc.								5
6.	(Other)								6

17.	Related information you use:	0	1	2	3	4	+	-	
1.	Machine shop practices								1
2.	Building construction								2
3.	Surveying procedures								3
4.	Electronics lab work								4
5.	Color and design								5
6.	Data processing								6
7.	Strength of materials								7

18.	Related duties:	0	1	2	3	4	+	-	
1.	Check the drawings of others								1
2.	Write specifications								2
3.	Make drawing changes								3

PERSONAL OPINION QUESTIONS BASED ON YOUR EMPLOYMENT EXPERIENCES

Please check "Yes" or "No".

			Yes	No	
19.	1.	Do you feel that draftsmen should be trained to work with automated drafting devices?	☐	☐	1
		If yes, which devices are most likely to be used by the draftsmen in your field?			
	2.	(1) Computers	☐	☐	2
	3.	(2) Digitizers	☐	☐	3
	4.	(3) Plotters	☐	☐	4
	5.	(4) (Others, please name, ________	☐	☐	5
	6.	If the answer to question 1 was "yes", should the training be before they seek their first drafting job?	☐	☐	6
	7.	If the answer to question 1 was "yes", should the training be on the job, after some experience?	☐	☐	7
20.	1.	Should draftsmen try to be competent in more than one major field, so as to be able to change jobs from Mechanical Drafting to Electronics or Architectural, or Structural or Civil?	☐	☐	1
	2.	More than 2 major fields?	☐	☐	2
	3.	Do you think that draftsmen should be trained in greater depth in one field so as to specialize in that field?	☐	☐	3
	4.	Or do you think that they should be trained in greater breadth so as to be more flexible in their work?	☐	☐	4

21. What suggestions would you like to offer for improving the instructional programs in drafting on the high school or junior college levels?

APPENDIX C

MATERIALS FOR THE INTERVIEWS WITH DRAFTING INSTRUCTORS

C-1 Letter to the Deans to Arrange the Visits
C-2 Information Sheet to Instructors
C-3 Check List for the Drafting Instructor

Dear Mr. ________

As of our phone conversation, I am enclosing three sets of the check list used in the interviews with junior college drafting instructors at your college.

Your interest and cooperation in the current study of drafting training programs in California junior colleges is truly appreciated. It is most satisfying to find so much support coming from busy instructors in the junior colleges throughout the state. The information from the first part of the study is now being tabulated and results should be forthcoming soon to provide a picture of the number and types of drafting programs currently offered.

As you will recall from our phone conversation, the design of the study includes a program of visits to junior colleges that have demonstrated progress in planning for and providing instruction in computer assisted design and drafting for numerical control, or colleges that have established option programs in the specialized disciplines of engineering and production. Now that we have identified the colleges that are active in innovative programs in drafting, the next step is to visit with the instructors and obtain some answers on the content and emphasis of their courses. It is believed that those schools that have worked out some option programs can be very helpful to new junior colleges and those wishing to up-date their programs not only in California, but also throughout the country. For this purpose I will be looking forward to the tour of your facilities, and visits with your drafting instructors.

In conducting interviews at several junior colleges it has appeared to be more convenient to have the check lists sent to the instructors some time before the visit so they can fill them out at their convenience and leave more time for discussion of their reactions and individual interest at the time of the interviews. For that reason, I am enclosing enough check lists to obtain the required responses. This will also make it possible to obtain some responses from each one, in the event that one or more might be unavailable during the time scheduled for the interviews.

This same check list is being used in interviews with 240 draftsmen in industries throughout California in order to compare the needs of draftsmen on the job with the emphasis of instructors in the colleges. To some of the instructors who helped me pretest this instrument it sounded too much like an investigation or evaluation of their programs. And so it might seem because it is seeking some very basic information regarding their course objectives. But no instructor need be concerned about a critique of his program as the data obtained will be processed with that from other junior colleges and only the collective responses will be tabulated. This is not in any way an accreditation study of any single program, instructor or junior college.

I hope you will find this to be an interesting and valuable study with results that will serve to show that education is keeping pace with the needs of industry on a very practical and elemental level, and that a compilation and dissemination of this material will aid in the advancement of the drafting profession.

If you have any questions regarding this visit or the enclosed materials, please call me collect at Citrus College. The best days on which to call me will be Mondays and Fridays, as I am attempting to schedule all visits to colleges and industries on Tuesdays, Wednesdays, and Thursdays. If you have any questions, please call me at 213-335-0521, Ext. 368.

I appreciate your cooperation and look forward to visiting with you in the near future.

Very truly yours,

William T. Husung, Jr.
Project Director
Citrus College Drafting Study

mpo

Encl.

CITRUS COLLEGE VOCATIONAL DRAFTING STUDY

QUESTIONNAIRE ORIENTATION

General information regarding the Study of Vocational Drafting Training in Junior Colleges in California.

A. The advent of automation has produced confusion and anxieties over the status and needs of the draftsman.
B. The American Institute for Design and Drafting recently predicted that 212,000 new draftsmen will be needed in this country by 1975.
C. Engineering majors no longer meet the needs for draftsmen as drafting has been almost eliminated from their curriculum.
D. The training of draftsmen will become increasingly the responsibility of the vocational-technical programs of the junior colleges.
E. Drafting jobs can meet the needs of a problematic segment of our society for white-collar status in professional-technical employment.
F. Increased diversity and specialization in drafting jobs demand the identification of cluster courses and specialized optional training in the various programs and levels of drafting instruction.

THE OBJECTIVES

The purposes of this study will be to determine:

A. The extent to which current practices in training are responsive to current needs of draftsmen in industry.
B. The effects of automation on the needs of industry for draftsmen with general vs. special training, both for entry and advancement.
C. The curricular revisions in vocational drafting programs in California junior colleges to meet the needs of draftsmen

The Nature of the Project

Selected industries throughout California known to employ draftsmen will be surveyed and approximately 1% of the 22,000 draftsmen in the State will be interviewed along with their supervisors to determine the effects of automation on the nature of their jobs and on the training needed for them.

A survey of all the junior colleges in California will be made and 20 will be selected for visits to determine the effects of automation on the instructional programs for draftsmen, and their plans for specialized drafting options and other curricular revisions.

It is confusing to attempt a study of the offerings of colleges by comparing their course titles or even the course descriptions in catalogs. A more meaningful study would need to investigate the scope and emphasis of the content of individual courses or programs.

The purpose of the checklist questionnaire is to identify those skills used by draftsmen and the functions they perform that relate to the instructional objectives in the specialized options of drafting programs.

The results of this project should prove useful to junior college instructors who are concerned with meeting the ever-changing needs of the drafting profession. Summaries will be available upon request.

CITRUS COLLEGE DRAFTING STUDY

Survey of Drafting Instructors

______________ Instructor's Name

______________ Course Title

Directions: The skills listed below are representative of many fields of drafting and design. It is very unlikely that any one drafting instructor will find a majority of the items highly important in his subject area. However, a consensus of instructors will help determine which skills are important as instructional objectives in general programs as well as in specialized options. Please check the appropriate column to indicate the importance to your particular drafting course or program of each of the items listed using the rating keys as follows:

0 For things that are not a part of your program

1 For things that are occasionally presented or lightly introduced in your program but have little importance to the student's progress.

2 For things that students are expected to know about but are not expected to master in order to pass the course.

3 For things that most students are expected to master and are highly important to your program.

4 For things that all students who complete the program must know or able to do.

+ For things you would like to add to your program or increase the emphasis now placed on it in your program.

- For things you now have in your program that you feel should be omitted or de-emphasized. Don't try to check every item for these last two columns. Only those items that stand out in your needs should be checked. Disregard the figures in the column at the far right, they will be used only for data processing.

R. ☐

T. ☐

L. ☐

1. Reading blueprints of:

	0	1	2	3	4	+	-	
1. Mechanical details								1
2. Mechanical assemblies								2
3. Tool drawings								3
4. Installation drawings								4
5. Wiring diagrams								5
6. Electrical schematics								6
7. Electronic schematics								7
8. Printed circuit boards								8
9. Welded modules								9
10. Logic diagrams								10
11. Building plans, single story								11
12. Building plans, multiple story								12
13. Architectural details								13
14. Structural steel details								14
15. Structural steel diagrams								15
16. Maps or site plans								16
17. Piping diagrams								17
18. Piping parts and assemblies								18
19. Flow charts and diagrams								19
20. Pneumatic or hydraulic drawings								20
21. Plumbing, heating, air cond. plans								21
22. Sheet metal drawings								22
23. Welded fabrication drawings								23
24. (Other)								24
25. (Other)								25

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Title
A STUDY OF THE EFFECTS OF AUTOMATION ON THE NATURE OF THE WORK OF THE DRAFTSMAN IN INDUSTRY, AND THE INNOVATIVE PROGRAMS OF INSTRUCTION FOR AUTOMATED DRAFTING IN SELECTED JUNIOR COLLEGES IN CALIFORNIA TO BE USED FOR CURRICULAR REVISION

Personal Author
Husung, William T., Jr.

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Draftsmens Needs - Automated Drafting - Specialization in Drafting - Flexibility of Draftsmen - Drafting Curriculums.

Abstract

A survey of 87 public junior colleges in California was made to determine the types of drafting programs currently being offered and to learn the effects of automation on the drafting curriculums. On the basis of this survey 20 colleges were selected for visits and 45 instructors were interviewed to determine the course content and emphasis in their drafting programs.

Interviews with 219 draftsmen and 58 drafting supervisors in industry and professional offices were conducted to learn the needs of draftsmen in the five major areas of drafting: architecture, civil, electronics, mechanical and structural engineering. A check list of 173 job skills and functions was used in the interviews of draftsmen and instructors to compare the needs of draftsmen as they might vary in the major fields and to compare their needs with the skills and knowledges emphasized by drafting instructors.

While the results of the study showed that to date automation has had very little effect upon the needs of draftsmen, the participants offered some practical recommendations for curriculum revisions for up-dating drafting programs. Some expectations were expressed for increased use of various types of devices for automated drafting and design.